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Volume 7-1
Final Report

7

Data Book
D180-27477-7

Space Station Needs, Attributes, and Architectural Options Study

(NASA-CR-173700) SPACE STATION NEEDS, ATTRIBUTES AND ARCHITECTURAL OPTIONS STUDY. VOLUME 7-1: DATA BOOK. SCIENCE AND APPLICATIONS MISSIONS Final Report (Boeing Co., Seattle, Wash.) 508 p HC A22/MF A01 N84-27796 Unclas G3/18 00803

Arthur D. Little, Inc.
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Space Station
Needs, Attributes and Architectural Options Study

Contract NASW-3680

D180-27477-7

Final Report

Volume 7-1

Data Book

Science and Applications Missions

April 21, 1983

for

National Aeronautics and Space Administration

Headquarters

Washington, D. C.

Approved by [signature]

Gordon Woodcock,
Study Manager

Boeing Aerospace Company

P. O. Box 3999

Seattle, Washington 98124

BOEING

FOREWORD

The Space Station Needs, Attributes and Architectural Options Study (Contract NASW-3680) was initiated in August of 1982 and completed in April of 1983. This was one of eight parallel studies conducted by aerospace contractors for NASA Headquarters. The Contracting Officer's Representative and Study Technical Manager was Brian Pritchard. The Boeing study manager was Gordon R. Woodcock.

The study was conducted by Boeing Aerospace Company and its team of subcontractors:

Arthur D. Little, Inc. (ADL)	Materials Processing in Space
Battelle Columbus Laboratories	Materials Processing in Space
ECON, Inc.	Pricing Policies and Economic Benefits
Environmental Research Institute of Michigan (ERIM)	Earth Observation Missions
Hamilton Standard	Environmental Control and Life Support Equipment
Intermetrics, Inc.	Software
Life Systems, Inc. (LSI)	Environmental Control and Life Support Equipment
Microgravity Research Associates (MRA)	Materials Processing in Space
National Behavioral Systems (NBS)	Crew Accommodations and Architectural Influences
RCA Astro-Electronics	Communications Spacecraft
Science Applications, Inc. (SAI)	Space Science

This document is one of seven final report documents:

D180-27477-1	Volume 1, Executive Summary
D180-27477-2	Volume 2, Mission Analysis
D180-27477-3	Volume 3, Requirements
D180-27477-4	Volume 4, Architectural Options, Subsystems, Technology, and Programmatics
D180-27477-5-1	Volume 5-1, National Defense Missions and Space Station Architectural Options Final Report (SECRET)
D180-27477-5-2	Volume 5-2, National Defense Missions and Space Station Architectural Options, Final Briefing (SECRET)
D180-27477-6	Volume 6, Final Briefing

D180-27477-7-1	Volume 7-1, Science and Applications Missions Data Book
D180-27477-7-2	Volume 7-2, Commerical Missions Data Book
D180-27477-7-3	Volume 7-3, Technology Demonstration Missions Data Book
D180-27477-7-4	Volume 7-4, Architectural Options, Technology, and Programmatics Data Book
D180-27477-7-5	Volume 7-5, Mission Analysis Data Book

Note: The volume 7 data books will be distributed to a limited number of requestors.

The study task descriptions and a final report typical cross reference guide are found in Appendix 1.

The Boeing and subcontractor team member are listed in Appendix 2.

Acronyms and abbreviations are listed in Appendix 3.

VOLUME 7-1

Data Book

Science and Applications Missions

TABLE OF CONTENTS

7.1.1 Summary

7.1.1.1 User Commentaries

Interview by Anderson on 29 September with:

Prof. Albert Belon -- Assistant Director of Geophysical Institute, Univ. of Alaska
Organized Landsat work in State of Alaska

Believes that remote sensing can benefit from operations on a Space Station.

Improvements to instruments

Increasing resolution to 8m from Landsat's 80m (military becomes concerned if resolution is better than 1 m).

Cover full wavelength spectrum. Include radar to pentetrate clouds.

Obtain stereo images by looking at same location from two locations along orbit, or from two vehicles.

Use crew

To delete clouds and other bad observing conditions. Thus reduce data flow.

Select targets and optimize observing parameters.

Objectives

Identify arctic energy resources.

Identify source of oil spills.

Study morphology of ice-marginal ice zone, edge of ice.

Orbit: high inclination (> 70°) to cover arctic.

Other users

State of Alaska: Governor's Office, Juneau
State Division of Geophysicsl and Geological Sciences
Jim Anderson - Anchorage
Paula Krebs - BLM, Anchorage
Dave Carnegie - USGS/EROS (Skyline Bldg., Anchorage) (907/271-4065)

Interview by Anderson on 29 September 1982 with:

Prof. Juan Roederer -- Space Plasma Physicist
Director of Geophysical Institute, University of Alaska

Discussed general ideas. He suggested:

- Particle accelerator space physics
- Laboratory plasma physics using large magnetic field coils. (suggests Al Wong of UCLA as a collaborator)
- Cosmic ray experiments
- Gradients in magnetosphere to be measured by an array of free-flyers
- Zero-g biology
- Zero-g mechanics -- use to make a teaching film on classical mechanics

Interview by Anderson on 20 October 1982 with:

Dr. Patricia Reiff -- Dept. Space Physics, Rice University, Houston

Dr. Reiff studies magnetospheric physics and is a data analyst, not an instrument builder.

Space station not so good for in situ plasma studies because of disturbance and contamination of the environment by the station.

The station should be able to support the following types of measurements:

Plasma experiments using tethers and sub-satellites

Remote sensing: of ionosphere (xray, UV, etc.)
of geocorona
of plasmasphere (using Faraday rotation of signal from remote transmitter)

Active experiments: Echo experiment with energetic (> 40 keV) electrons out to magneto puase
Initiate lightning discharge from ionosphere to troposphere using electron beam

Interview by Anderson on 30 September 1982 with:

Mr. John Miller -- Geophysical Institute, University of Alaska
Operates Northern Remote Sensing Laboratory (NRSL) for Alaska at the NASA-Gilmore Creek Tracking Site

Miller processes Landsat 3&4 images in real time for use by customers in the State of Alaska and elsewhere. Using the capabilities he points out the advantages of operation by crew and the uses of the images.

Uses of Landsat images in Alaska

Ice cover
Forest fires
Spring breakup of rivers/flooding
Agricultural assessment
Snow boundary retreat for wildlife control
Volcano monitoring -- retreat of ice from crater
Navigation among shoals -- look at low tide
Most of the above require prompt availability of the imagers

Crew/operator functions

Select desired images, reducing data flow. Use narrow angle camera to view only targets of interest.

Correct selected images for obliquity. Correct selected images using adjustable photometric transfer function in each wavelength channel. View images on monitor, adjusting transfer functions until features of interest are most clearly delineated.

Store/telemeter/print only optimal image.

Data flow

Landsat multispectral scanner: 3240 x 2460 pixels, 6 bits of grey, 4 wavelengths = 1.9×10^8 bits/image

Transmits one frame in 25 seconds.

New thematic mapper on Landsat 4 has 9x the bit rate of MSS.

Present NRSL uses 8 disks to store 20 images. Maniuplated images can be viewed on B&W monitor. Images printed in color or B&W with higher resolution (see sample prints).

An improved station such as on Space Station should store 100 or 200 images.

Pictures are available 1/2 hr after they are transmitted instead of 2-3 weeks.

Interview by Anderson on 21 October 1982 with:

<u>Prof. C.R. O'Dell</u> -- Chief Scientist for Large Space Telescope (LST)
Recently left NASA-MSFC and joined faculty at Rice

UV-VIS-IR astronomy highly desirable from space because effects of atmosphere are removed.

Need for manned station as opposed to an unmanned platform not obvious because of the following:

- Interference is of great concern: vibration
  chemical contamination

  - Vibration: Image resolution $\leq$ 1/2 arc-sec, thus vibration < 0.1 arc-sec.

  - Contamination: Particles in FOV look like IR stars. Deposits covering 1% of mirror undetectable. Alow 5% in 5-year life. Criteria $\leq$ 40 Å deposition of organics in 5 years.

  Note: Machine oil and water from graphite epoxy (30% H_2O) are problems.

- Data: Expect order of 10^{10} bits/day.

  On LST 1/3 of data is transmitted real time to ground thru TDRSS. Balance recorded. This will be sufficient real time. Feels that data are best sent to ground. <u>Wants to go on record that in the view of most astronomers, the scientists should be</u> on the ground interpreting their data.

- Size: Aperture of LST is 2.4 m, limited by diameter of shuttle payload bay.

  Larger mirrors are desirable but require technology to assemble multi-element mirrors in orbit.

  Note: Multi-element mirrors on earth are not yet operating in phase coherence.

- Orbit: ∿ 500 km altitude, above atmosphere and below Van Allen belts.

  Any inclination is ok as long as part of it is in the dark.

  Equatorial orbit avoids south Atlantic anomoly in belts.

fmh

RICE UNIVERSITY
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF SPACE PHYSICS
AND ASTRONOMY

F. CURTIS MICHEL
Andrew Hays Buchanan Professor
of Astrophysics

HOUSTON, TEXAS
77001

October 4, 1982

Dr. Hugh R. Anderson
Science Applications, Inc.
13400B Northrup Way, Suite 36
Bellevue, WA 98005

Hugh,

In response to your letter of 4 Oct., I have only a few obvious comments, reflecting the state of my thoughts the last time I gave much serious thought to the use of a space station (C. A. 1969). Basically, I think that:

1) A space station, for most scientific purposes, will mainly be an office. By it's vary nature, it will polute the local environment with outgassing and electromagnetic radiation and inside one with have a multitude of noise polution. It will instead be a place where data and instruments are gathered for analysis or refurbishment.

2) A secondary use, along the above lines, would be as an intermediate assembly and refueling depot for high energy missions or complex spacecraft (e.g. large antennae, which could more easily be assembled in place rather than engineered to unfold, etc.)

3) As a correlary to 1, scientific satellites to be serviced should be in low-energy-transfer orbits relative to the space station (l.e. small Δ inclination and relatively small Δ h). Otherwise you can't get from the space station to the Space Telescope, for example. Servicing of the Space Telescope and similar facilities makes a lot more sense from a space station than from the ground.

4) As a correlary to 3, one needs to design a "space to space" shuttle to travel between the space station and the satellites in question.

Not much, but you're welcome to it.

Best wishes,

F. C. Michel

FM/lb

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama
35812

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NASA

Reply to Attn of: ES51

October 13, 1982

Dr. Hugh Anderson
Science Applications, Inc.
13400B Northrup Way, Suite 36
Bellevue, Washington 98005

Dear Hugh:

In response to your questions, I have enclosed a set of material which addresses the interests of the solar terrestrial community in the space platform/space station mission. Enclosure A is a general requirements draft narrative on solar-terrestrial space station requirements written for the Committee on Solar and Space Physics and a summary of those requirements. Enclosure B is the final report of the STO Science Study Group which gives detailed science rationale and instrument requirements for a space platform/space station. Enclosure C is a paper describing the science that would be done from a manned space platform or station in solar terrestrial research, and Enclosure D is a report on a Workshop held in 1976 to address the manned space station possibilities in solar terrestrial physics. I hope that you will find these materials useful to your study.

Sincerely,

Rick Chappell

Charles R. Chappell
Chief
Solar-Terrestrial Physics Division

4 Enclosures

All four originals loaned to Boeing.

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama
35812

NASA

Reply to Attn of: PS02 (82-93)

October 20, 1982

Dr. H. R. Anderson
Science Applications, Inc.
13400B Northrup Way
Suite 36
Bellevue, WA 98005

Dear Hugh:

Thanks for your letter of October 6, 1982, (written while you were at the Shuttle Environment Workshop?) reminding me to send you the enclosed information. I have enclosed: 1) the Solar Terrestrial Observatory Science Study Group Final Report; 2) a copy of the STO design and analysis study for Space Platform; and 3) a copy of the 1977 Workshop on STO from a manned Space Station.

In addition, in January I have an AIAA paper coming out on STO from Space Station, and I expect that MSFC may decide to look at STO technology needs specifically oriented toward Space Station.

There are several of us who feel that the Space Station program offers a unique opportunity to begin applying the scientific knowledge presently in hand toward a broadened program to investigate and understand the interaction of solar activity on the earth's environment. The "building blocks" of this approach are presently available or are being developed through the Shuttle/Spacelab program.

By using the combined capabilities of presently defined instruments to simultaneously monitor the earth's atmosphere, ionosphere and magnetosphere along with solar output and variability, we can begin to obtain correlative data on dynamic interactions. By combining this capability with the ability to perform controlled, active experiments to induce and study dynamic interactions in the earthspace environment, we further enhance the investigative capabilities of the STO. The final ingredient is the availability of the scientist-in-the-loop armed with an extensive data archiving and processing capability.

See bookshelf

I hope this information will be helpful to you. I believe that the Space Station offers a unique opportunity for major advances in the understanding and application of solar-terrestrial interactions, which portends significant benefits to mankind.

Best regards,

W. T. Roberts

3 Enclosures

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Bell Laboratories

600 Mountain Avenue
Murray Hill, New Jersey 07974
Phone (201) 582-3000

October 27, 1982

Dr. Hugh R. Anderson
Science Applications, Inc.
13400B Northrup Way, Suite 36
Bellevue, Washington 98005

Dear Hugh:

This is in response to your letter of 4 October regarding Space Station Concepts. As you are aware, an enormous amount of work on platform ideas have been carried out in the solar-terrestrial community over the years. In preparation for the next Space Science Board meeting (4th of November), the Committee on Solar and Space Physics has put together the enclosed material for discussion at that time. It should be useful for your considerations.

If any of this material is used, please make sure that appropriate acknowledgement is given to the Committee on Solar and Space Physics.

Sincerely,

L. J. Lanzerotti
Chairman, Committee on
Solar and Space Physics

MH 1E-435

Copy to:
Dr. R. Hart

Space Science Board.

REQUIREMENTS FOR SOLAR AND SPACE PHYSICS RESEARCH FROM A SPACE STATION

Goal

Coordinated, simultaneous observation of the solar-terrestrial environment with measurements tailored to respond to solar and terrestrial events and to track their effects.

Background

- Unity of discipline of solar-terrestrial physics for the next decade emphasized in several NRC reports (1,2,3,4).
- Research strategy for the discipline outlines required free-flying missions to specific regions of space (UARS, ISPM, OPEN) as well as shuttle and platform-based missions to address first priority questions (facility (SOT) and PI levels). (3)
- Experience of the discipline in station-based science activities during the Skylab era and now the Shuttle era.
- Involvement of the discipline in workshops that looked to applying shuttle-class instrumentation to long-duration flights (5,6,7).
- Active involvement of the community in assessing and defining science that can and should be accomplished with concepts such as the Solar-Terrestrial Observatory and the Advanced Solar Observatory (8,9).
- Summary: discipline with longest history of active consideration and study of the use of shuttle and platform concepts for addressing first priority science questions.

Approach

1. Remote sensing of the sun and atmosphere from Earth orbit.
2. Active probing, remote sensing, and passive <u>in situ</u> measurement of the magnetosphere.
3. The above measurement techniques are carried out from a single space station-based configuration.
4. Scientist/observers operate the instruments using real time information from other free-flying spacecraft and responding to solar-terrestrial events.

Specific Requirements

1. Capability to accommodate spacelab class instrumentation and supporting equipment with interfaces similar to shuttle.

2. Ability to independently point multiple clusters of instruments for solar and atmospheric studies (sub arc second for solar telescope for solar features and full disk measurement).

3. Ability to orient the station for electron beam and wave injection relative to Earth's magnetic field.

4. Antenna deployment and orientation capability (1,000 meter dipole, 50 meter magnetic loop, phased array, and long boom astronaut configurations).

5. Large weight and volume capability for solar and atmospheric telescopes.

6. High weight and power for active beam, plasma, and wave investigations (energy storage system).

7. Capability to deploy, spin-up, and retrieve subsatellites for ambient plasma measurement and chemical release.

8. Capability to deploy tethered subsatellite.

9. Ability to act as a central base for receipt of data from free-flying satellites in solar wind, distant magnetosphere and ionosphere.

10. Data system to permit rapid access to and intercomparison of multi-instrument data by different institutions.

11. Man-tended interaction for instrument refurbishment, recalibration, repair, replacement, and addition.

12. Long duration observing time to cover -

    Magnetic storms - minutes to days
    Solar rotation effects - days to months
    Terrestrial seasonal effects - months
    Solar cycle effects - months to years (22)

13. Orbital requirements - Initially - Low Earth Orbit, >400 Km, high inclination (57^{o} minimum, 70^{o} - 90^{o} preferable)

    Later - Geosynchronous orbit for:
    a. Continuous solar observations
    b. Hemispherical Atmospheric observations
    c. Active probing in middle of magnetosphere.

References

1. Space Plasma Physics, The Study of Solar System Plasmas. NAS-NAC.
2. Solar System Space Physics in the 1980's: A Research Strategy. NAS-NRC.
3. Solar-Terrestrial Research for the 1980's. NAS-NRC.
4. Physics of the Sun. NAS-NRC, in progress.
5. NASA Workshop on Solar-Terrestrial Studies from a Manned Space Station. NASA/MSFC.
6. NASA Guntersville Workshop on Solar-Terrestrial Studies. NASA/MSFC.
7. UAH/NASA Workshop on Space Science Platform. NASA/MSFC
8. The Solar-Terrestrial Observatory. NASA/MSFC and UCSD
9. Advanced Solar Observatory. NASA.

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Baylor College of Medicine
CORA AND WEBB MADING DEPARTMENT OF SURGERY
Division of Experimental Biology • 713 790-4650

November 17, 1982

Derek Mahaffey
Boeing Aerospace Company
Mail Stop 84-06
P. O. Box 3999
Seattle, Washington 98124

Dear Mr. Mahaffey:

Thank you for your letter of 5 November with which you included a brochure describing potential opportunities on a Space Station. I am grateful for the chance to contribute towards your concepts of such a venture. However, I found the fact sheet rather inappropriate for Life Sciences so will put my ideas in the following form.

By way of background, my own area of expertise is the regulation of red blood cell production. To address certain facets of well-recognized, space flight-induced changes in this system I have had a research contract with NASA for several years. Recently I have been fortunate enough to have 2 experiments tentatively selected for SL-IV. Data from these will enhance the value of results obtained in a less extensive experiment (on which I am a Co-I) to fly in SL-I.

I am sure that each biologist you ask to contribute towards a Space Station concept will express the bias inherent in their own work. I am no exception but believe there are several quite specific reasons why it would be especially logical to study red blood cell production during a long-term sojourn in space. Firstly, there are consistent changes of unknown etiology and uncertain significance for long-term missions. Secondly, the red blood cell mass, because of the relatively long life-span of the end cell, responds fairly slowly to insults. Although the changes that result in alterations of red cell mass can occur very rapidly (within minutes), and this provides the rationale for our Spacelab studies, it is only by extrapolation can we anticipate the ultimate effect. Some long-term studies, on both animals (rats, monkeys) and man, are therefore highly desirable. I also feel that changes in red blood cell production should be investigated in parallel with changes in leukocytes and in platelets. Evidence from the ASTP mission suggested impairment of leukocyte function but this has not been investigated in depth. Since platelets seem to be involved in decompression sickness it is imperative, given that some EVA will be needed in the Space Station to fully document quantitative and qualitative changes in platelet function.

Having addressed some rather specific items, I would also like to make the plea that these studies be performed on a "whole animal" basis.

That is that hematology, in this case, not be looked at in isolation but considered part of a multi-P.I. effect investigating multidisciplinary projects. Although we have to a certain extent started this approach on SL-IV, I believe it to be even more critical in longer term flights which are still going to be extremely limited in terms of resources. As part of this multidisciplinary approach in my own area a project involving hematology, bone and muscle would be an ideal starting point. There is a strict relationship between red blood cell mass and lean body mass and we are becoming increasingly aware of the importance to erythropoiesis of the micro-environment provided by the bone matrix.

In order to accomplish these types of goals, 3 units would appear necessary; a fairly substantial animal facility housing rodents (mice, rats) and small primates (e.g. squirrel monkeys); a well equipped biomedical research laboratory and a physiology laboratory. It seems to me such units should evolve from a basic "First Aid" station, some rudimentary version of which must surely be available right from the start if only from a crew health monitoring viewpoint. The scope of this station could then evolve into a basic biomedical research laboratory followed by parallel development of the animal facility and the (human) physiology laboratory. Among the equipment I would envisage as essential is blood draw and processing apparatus, centrifuges, mass measuring instruments, cardiac monitors, biopsy preparation instruments, exercise performance monitors and probably some equipment to assess vestibular function, although most of this will probably best be employed in short-term flights using Space-lab.

I trust these rather random thoughts will be of help to you in your planning.

If I can provide any further information please do not hesitate to contact me.

Yours sincerely,

C.D.R. Dunn, Ph.D.
Research Associate Professor
Division of Experimental Biology

CDRD/ht

RADIOSCIENCE LABORATORY
STANFORD ELECTRONICS LABORATORIES
DEPARTMENT OF ELECTRICAL ENGINEERING
STANFORD UNIVERSITY · STANFORD, CA 94305

December 16, 1982

Dr. Harold B. Liemohn
Boeing Aerospace Company
P.O. Box 3999
Seattle, WA 98124

Dear Harold:

I am responding to your letter of 5 Nov 82 regarding a new Space Station program. We have little to add to your present store of suggestions for uses of a Space Station. However, I would like to emphasize the growing importance of techniques used to modify the ionosphere and magnetosphere.

An example is wave injection at very low frequencies for the purpose of altering the radiation belts. These experiments require relatively high power, in the range 1-100 kW. They also would benefit from the presence of an on-site operator. Free-flyers would be needed to monitor the waves and detect the particle perturbations. One limitation of the Shuttle for such experiments is the one-week period in orbit. A much longer time would be needed to properly sample the full range of disturbance levels in the medium.

These requirements would be satisfied by the proposed Space Station.

Very truly yours,

R. A. Helliwell
Professor

RAH:kd

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UNIVERSITY OF NEVADA RENO

Mackay School of Mines
Office of the Dean
University of Nevada Reno
Reno, Nevada 89557-0047
(702) 784-6987

January 3, 1983

Mr. David L. Tingley
Boeing Aerospace Company
Mail Stop 84-06
P.O. Box 3999
Seattle, WA 98124

Dear Mr. Tingley:

With reference to your letter of October 26 regarding NASA planning for a space station. A heavy travel schedule did not allow timely reply to your request for information. Please do not interpret this as a lack of interest on my part. I was extensively involved as Chairman of a Working Group on Commercialization of Space for the Secretary of Commerce during this period.

I feel that NASA's next great challenge is to build an maintain a geosynchronous platform for earth observations research. Such a platform should allow continuous observations of North America with a 30 meter ground instantaneous field of view in solar reflected wavelength bands and 100 meter GIFOV resolution in the thermal infrared.

If you are still interested in my views along these lines do not hesitate to give me a call at (702) 784-6987.

Sincerely,

James V. Taranik
Dean

JVT/ml

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Research Proposal Submitted to

Code E

National Aeronautics and Space Administration

Washington, D.C. 20546

INNOVATIVE UTILIZATION OF THE SPACE STATION PROGRAM

FOR A MICROGRAVITY PHYSICS LAB EXPERIMENT TO SEARCH FOR GRAVITATIONAL WAVES

Submitted by

Department of Space Physics and Astronomy
William Marsh Rice University
P.O. Box 1892
Houston, Texas 77251

Amount Requested: $29,626
Date of Submission: 15 December 1982

This proposal is valid for a minimum of six (6) months from the date of submission.

Mr. L. C. Griffin, Administrative Coordinator of Sponsored Research, is authorized to conduct negotiations for Rice University.
Telephone: (713) 527-4820

Endorsements:

John W. Freeman,
Principal Investigator
Department of Space Physics and Astronomy
Rice University
Houston, TX 77251
(713) 527-8101 ext. 3524
Until June '83:
Code 601
Goddard Space Flight Center
Greenbelt, Md. 20771
(301) 344-7251

F. Curtis Michel
Co-Investigator
Department of Space Physics and Astronomy
Rice University
Houston, TX 77251
(713) 527-4925

Norman Hackerman
President, Rice University

ABSTRACT

We propose to investigate the requirements for a gravitational wave detector to be flown aboard the Space Station and to evaluate the feasibility and advantages of such a detector. Ground based gravitational wave detector system design is complicated by the requirements to mechanically isolate the antenna [a large aluminum bar] from its surroundings and to cool the antenna to reduce thermal noise. Space provides the ideal environment to mitigate both of these problems. On orbit and in the vacuum of space, an antenna mass can float freely in a vibration-free environment and can be readily cooled. We envision the possibility of a several order of magnitude decrease in the threshold for graviational wave detection. Moreover, an experiment as complex as a gravitational wave detector can benefit from a human operator and hence is a logical choice for the Space Station.

I. Introduction and Objectives:

The microgravity environment of low earth orbit provides unique opportunities for basic research in astronomy and astrophysics. We recommend that a portion of the Space Station be dedicated to a microgravity physics laboratory and we suggest an experiment that it be configured to accommodate, a detector to search for gravitational waves of cosmological origin.

Gravitational waves have been predicted from a variety of astronomical objects such as black holes, supernovae, neutron stars, binary stars, an even as a component of the primordial radiation [Smarr, L. L. 1979; Thorne and Braginskii, 1976; Press and Thorne, 1972; Gibbons and Hawking, 1971] Confirmation of their existence is of the utmost importance. However, the detectability of such radiation with ground-based detectors has been greeted with skepticism [Rees, 1972] and the results of attempts to detect gravitational waves have been controversial [Weber et al., 1974; Kafka, 1974; Maischberger, 1974]. A new offensive is needed if the issue of gravitational waves is to be settled and the era of gravitational wave astronomy opened.

II. The Gravitational Wave Detector:

An orbiting detector appears to offer important advantages. Previous gravitational wave antennas have consisted of a large mass whose resonant motion, excited by a gravitational wave train or impulse, can be detected electronically. Great care must be taken to mechanically isolate the mass to prevent excitation by background vibrations. In the type of experiments pioneered by Weber, the mass, an aluminum bar of a meter or so in length, is supported by vibration absorbers consisting of alternate layers of metal and rubber. Subsequent experiments have used superconducting magnets and magnetic levitation [Carelli et al., 1974; Hamilton, 1971].. Inductive or capacitive pickups have been used to detect the motion of the bar. In an orbiting spacecraft, supporting the resonant mass by vibration dampers or superconductors would not be necessary. It would "float" freely once uncaged from a support frame. A second nearby mass of a different size and resonant frequency could be used as a reference mass from which to measure the motion of the first, or the resonant motion of the mass relative to itself might be monitored with laser interferometry.

A second fundamental limit to the sensitivity of ground based gravitation wave antennas is excitation of the resonant mass by thermal noise or Brownian motion. This problem has been attacked by cooling the aluminum bar with liquid He. Based on work done on the Stanford Space Gyroscope Experiment [Everitt, 1971], it appears possible to cool a space borne mass to a few millidegrees [Fairbank, 1971]. Fairbank has pointed out that this low temperature technology could be applied to a spacecraft borne gravitational wave detector. He estimates that a 10^6 fold increase in antenna sensitivity is possible for a space borne antenna assuming an operating temperature of 0.003K [Fairbank, 1971]. This would provide a 1000 fold increase in our seeing distance, enough to bring many other galaxies within view.

A Space Station borne gravitational wave antenna would have two additional advantages over a ground based system. First, since the atitude of the orbiting bar is fixed in inertial space, the antenna could be maintained in a fixed orientation relative to a potential radiation source, such as the galactic center, for an indefinite time. This would allow a long data accumulation interval. The antenna could then be rotated to other directions for background runs.

Second, the relatively quiet radio background noise level in space would reduce the probability of accidental or spurious events detected by the electronic motion sensing system. Anticoincidence detectors will probably be required to remove possible cosmic ray excitations. Indeed, the effect of cosmic rays may prove to be an interesting, separate issue in that, in principle, one could get absolute energy calibrations for cosmic rays that stop in the cylinder. However, the preliminary task here will be to minimize cosmic rays as a source of interference.

In addition, because of the relative ease of isolating the resonant mass in space, it may be possible to plan an experiment using a number of masses each tuned to different frequencies and thus increase the spectrum of the detection system. Larger bars could be handled more easily in space, making possible the investigation of lower frequencies (Less than 1 KHz).

We also propose to evaluate the possible systems (e.g., laser optical) to detect motion in the resonant mass. Detection of normal mode motion of the mass relative to itself may be possible.

III. Alternate Approaches:

Several other space approaches to the detection of gravitational waves have been discussed, however, these include either precision doppler [Mashhoon, 1979] or laser tracking of spacecraft or the construction of large (~ 1 km) structures in low earth orbit [NASA, 1980]. These approaches will be costly and complex, requiring separate new space missions. Therefore, we propose the cooled resonant mass antenna carried aboard the space station laboratory as a logical first step in the space search for gravitational waves.

IV. Research Plan:

We propose the following objectives:

1. Research previous ground based gravitational wave experiments.

2. Design a preliminary space station borne gravitational wave detection system.

3. Draw up a list of Space Station requirments to accommodate the detector.

4. Estimate probable gains in sensitivity and list various design improvements.

Professor John W. Freeman will serve as Principal Investigator. Professor F. Curtis Michel will serve as Co-Investigator. Professor Freeman served as a Principal Investigator for the Apollo program and has over twenty years of experience in space physics and instrument design. Professor Michel will provide theoretical guidance in gravitational wave theory. We propose to consult with previous workers in the gravitational wave field and would welcome collaboration. Professor Freeman is on sabbatical leave at the Goddard Space Flight Center during the 1982-83 academic year.

UNIVERSITY OF MINNESOTA
TWIN CITIES

School of Physics and Astronomy
Tate Laboratory of Physics
116 Church Street S.E.
Minneapolis, Minnesota 55455

January 14, 1983

Dr. Hugh R. Anderson
Science Applications, Inc.
13400B Northrup Way, Suite 36
Bellevue, WA 98005

Dear Hugh:

This is in response to your letter soliciting ideas for science on the Space Station.

I have not filled out the questionnaire because it did not seem to have possible answers which fit my requirements.

In my opinion, the enormous costs which the Space Station will undoubtedly entail cannot be justified on a scientific basis alone. When one thinks of investments of this magnitude it is necessary to consider the whole range of physics; of accelerators for elementary particles and of large optical and radio telescopes and other large scale experiments which may be more important to physics as a whole than anything that can be done in the Space Station.

Furthermore, at the present time the scientific community is not even able to utilize Shuttle effectively. It has turned out that the cost of experiments in Shuttle is much greater than the costs that were being quoted at the time of design and congressional approval, and that the kind of money to effectively utilize Shuttle for scientific experiments is simply not available. In the scientific sense then Shuttle is presently a failure. I believe that either this problem should be solved so that Shuttle can be used much more cheaply or the space science community should go back to using individually tailored payloads, Delta rockets, etc.

I have heard that already NASA has committed a large amount of money to space station studies of the kind which you are undertaking. At the same time the Galileo project has been continually in trouble, the Solar Polar spacecraft was cancelled, and a number of other projects are starving for lack of funds. I think this bears out my opinion expressed in the first paragraph that Space Station will mainly take away money which could be more effectively used in other science projects.

If Space Station is to be justified, then it will be justified on considerations of national prestige, military use or colonization of space. In that case the design will be dictated by non-scientific considerations but it may be that two possible styles of design may cost the same and one may be more effectively used for science. At that time scientists could usefully be involved in the work of Space Station design, but I still believe that involvement of scientists at the present time is premature and serves only to lend a scientific blessing to a project which really should not be carried out in the name of science.

Sincerely yours,

Paul J. Kellogg

Paul J. Kellogg
Professor of Physics

PJK/sab

7.1.1.2 Payload Selection Procedure

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Spacecraft Payload Optimization

H. B. Liemohn, W. A. Reardon,
and R. L. Engel

Introduction

Many factors are considered in the selection and integration of scientific experiments for spacecraft payloads. Ideally, the payload should provide maximum scientific value subject to the finite limitations of cost, telemetry, power, weight, and volume imposed by the scope of the mission. The process of picking the payloads is frequently a source of consternation for proposers of experiments as well as mission administrators. Large amounts of money and maintenance of technical staffs as well as personal prestige and scientific careers are at stake in these deliberations. The unique nature of spacecraft experiments requires very specialized knowledge for the review process, which is usually only available from principal investigators of previous spacecraft experiments. Owing to the limited opportunities for missions, a small group of capable experimenters has emerged.

We are now embarking on a new era of space science research. With the advent of the space shuttle for near-earth research there will be ample opportunity for a much wider range of experiments. In addition to studies of the atmosphere and magnetosphere environment, it is anticipated that the shuttle will also carry a variety of experiments devoted to astronomy, materials processing, biomedical investigations, other commercial applications in communications and earth resource evaluation, and expanded applications of a military nature. There will also be many new opportunities for participation on deep-space probes to study the moon, sun, other planets, and interplanetary debris.

These expanded opportunities are accompanied by certain complications. NASA budget limitations will place severe constraints on the expenditures for individual experiments. There will be strong encouragement for new institutions to participate in the space program, which includes new inexperienced personnel. This will be partially offset in the shuttle program by the spacelab concept, wherein basic instruments are designed for repetitive usage in a variety of experimental objectives. The long duration of interplanetary missions demands a long-term commitment on the part of principal investigators, from experimental conception to data interpretation.

In this new era of broader mission objectives, much wider participation in spacecraft experiments is desirable. In such circumstances the selection of experiments is anticipated to become much more difficult owing to a variety of factors. First, the community of potential spacecraft experimenters has expanded enormously through our educational system. Second, much more diverse payload opportunities are expected to attract new areas of research which heretofore had not considered spacecraft laboratories for their investigations. Third, constraining conditions on individual payloads are apt to become much more elaborate as the experiments grow larger and more complex. Thus some systematic way of quantifying part of the experiment selection process might be appropriate at this time.

Method

The methods of operations research have been applied to many multiparameter decision situtations, and its application to spacecraft payloads appears to be feasible as well. The only new concept introduced here is parametric modeling of experiment options, a step that is frequently taken implicitly in the course of designing experiments but rarely used explicitly to evaluate them. Each proposed experiment is defined by a set of options specified by the proposer corresponding to successively higher levels of sophistication and scientific value. Once these options have been parameterized, all the proposed experiments must be graded quantitatively according to their relative scientific value; a method for making such judgments is suggested below. Most importantly, this value judgment can be based on scientific merit alone, independent of other nonscientific factors. Once this parameter array for the experiment options is defined, a straightforward application of integer programing techniques yields a selection of experiments for optimum usage of the total payload profile.

A given spacecraft mission is usually subject to five basic constraints. First, there is a limitation on the total cost of the mission which usually limits the total cost of all experiments. Second, the data obtained by the instruments must be telemetered to available receivers on the ground over a limited radio bandwidth which specifies the rate at which information can be transmitted. Third, the total power available to operate the experiments is limited by the generating capacity of the solar panels, radioisotope thermoelectric sources, or other devices. Fourth, the launch vehicle capability and the mission trajectory define the permissible payload weight. Finally, the volume of the payload is restricted by the launch vehicle configuration.

Thus for each experiment option we must define a cost C, a telemetry bandwidth T, a power requirement P, a weight W, and a volume V. Selection of a set of experiment options is subject to the following constraint inequalities:

$$0 \leq \Sigma\, C \leq CT_m \qquad (1)$$
$$0 \leq \Sigma\, T \leq TM_m \qquad (2)$$
$$0 \leq \Sigma\, P \leq PW_m \qquad (3)$$
$$0 \leq \Sigma\, W \leq WT_m \qquad (4)$$
$$0 \leq \Sigma\, V \leq VM_m \qquad (5)$$

where CT_m, TM_m, PW_m, WT_m, and VM_m are maximum limits on the consumption.

Establishing a scientific value for each experiment option S relative to all others is indeed difficult, particularly with diverse experiments. Nevertheless, it has been done repeatedly by payload selection committees, and it should be easier to quantify when other constraints can be ignored. As a practical matter, a group of experts might grade the options individually and then average their recommendations to obtain a consensus on each option. This technique is sometimes called the Delphi method after its origin as described in Appendix A. The ultimate objective, of course, is to maximize the scientific value

$$SV = \Sigma\, S \qquad (6)$$

for a prescribed group of options.

Finding the maximum of (6) subject to conditions (1)–(5) is the province of linear programing [e.g., *Dantzig*, 1963]. It consists of a rigorous mathematical procedure for examining various option combinations in the hyperspace of experiment parameters subject to the linear constraint conditions. Integer programing [e.g., *Hu*, 1969] is mandatory, since fractions of an experiment option are meaningless. The optimization process is illustrated by a simple analytic example in Appendix B.

While the mathematical procedure for linear programing is rigorous, the answer is not always unique. Sometimes more than one location in the hyperspace (combinations of options) will yield the same maximum scientific value and still satisfy the constraint conditions. Another important consideration is the fact that incremental changes in the constraint conditions can significantly alter the selection of options and the ultimate maximum scientific value. This is particularly true for integer programing where a particular option combination may lie on the border line of the constraint condition. Thus a small group of possible combinations might be more appropriately identified depending on the rigidity of the constraint conditions.

This optimization technique for payload selection provides an opportunity to perform variational studies under 'what if' conditions. For example, the addition of another power source might decrease the weight and volume available for the payload but would increase the available power and thereby modify the constraint conditions and change the option combinations. A change in the trajectory or speed on a distant planetary mission might significantly relax the weight requirement and allow additional experiments. In the course of building the experiments that have been selected there are frequently changes in individual operating parameters such as power, weight, or volume as well as revisions in cost estimates, and these changes occasionally lead to a reassessment of the optimum configuration. Finally, certain experiments are considered to be a mandatory part of the payload for housekeeping data, background levels, or perhaps public relations, and it might be interesting to ascertain the minimum scientific value needed to insure their inclusion.

The integration of payload experiments frequently imposes coupling conditions on two or more experiments. In many experimental studies the background noise for one experiment is the desired signal in another experiment. Similarly, small expansions of one experiment may add significantly to the scientific value of many others. Thus when one experiment is selected, certain other experiments are more attractive. This concept can be incorporated into the linear programing method by introducing coupled options with enhanced scientific value.

Duplication of experiments is another factor in payload selection. In some instances, redundancy is a desirable precaution against loss of vital measurements. In other cases, duplication would be wasteful of spacecraft resources and should be avoided. These alternative conditions in the selection process can be introduced by appropriate auxiliary constraints.

Example

In order to illustrate the method, experiment options have been modeled for a deep-space scientific research payload to another planet. The detailed option information is presented in Table 1 for seven experiments that might be considered for such a mission. The numerical entries are entirely arbitrary and are not based on any experimental design criteria. The seven proposed experiments consist of a television camera, a life sciences experiment, cosmic ray detectors, various plasma probes, a broad band radio receiver, a radio frequency sounder, and a mass spectrometer.

TABLE 1. Deep-Space Scientific Research Payload Model of Experiment Options

Option Description	Option Number	Scientific Value	Cost, 10^6 $	Telemetry, kbit/s	Power, W	Weight, kg	Volume, 10^3 cm^3
			Television Camera/Image Processor				
Basic camera	1	5	8	20	15	20	2
Data processor	2	4	10	10	16	21	2.1
Two-color camera	3	8	12	35	18	28	2.5
Data processor	4	7	13	18	19	30	2.6
Three-color camera	5	12	14	50	21	33	3.0
Data processor	6	10	15	24	21	34	3.0
Picture recorder	7	14	20	30	21	36	2.6
			Life Sciences/Amino Acids, Bacteria				
Air sampler	1	4	3	2	7	13	3
Sophisticated processing	2	6	5	5	8	14	3
Subsatellite	3	7	8	4	9	15	3.3
Low-altitude sampler	4	10	10	3	10	17	2.5
Lander	5	15	15	6	14	22	4.5
			Cosmic Rays/Geiger Tubes, Scintillators				
Geiger tubes	1	0.5	0.2	0.5	1	2	1.0
Telescope coincidence	2	1.5	0.7	2.0	6	5	3.0
Scintillators	3	3.0	1.3	4.0	5	4	2.5
Computer processing	4	5.0	1.7	3.0	7	5	4
Sophisticated array	5	7.0	2.0	5.0	8	5	4
			Plasma Probe/Langmuir Probe, Faraday Cup				
Langmuir probe	1	1.0	1.2	1.0	4	1	0.5
Faraday cup	2	1.5	1.4	2.0	5	1.5	0.5
Computer processing	3	3.0	1.7	1.0	8	3.5	1.5
Improved sensitivity	4	4.0	1.8	2.0	8	3.5	1.6
Sophisticated array	5	5.0	2.0	3.0	10	4.0	1.8
			Radio Receiver/ULF, ELF, VLF, LF				
Limited band LF	1	0.5	0.3	0.5	5	10	0.5
Broadband VLF–LF	2	1.5	0.4	5.0	4	10	0.5
Ultra broadband ULF–LF	3	4.0	0.5	15.0	7	12	0.5
Computer processing, VLF–LF	4	2.0	0.8	2.5	10	17	1.5
Computer processing, ULF–LF	5	3.0	1.0	3.0	11	18	1.5
Record/playback	6	5.0	2.0	2.0	14	20	2.0
			Radio Sounder/LF, MF, HF				
Discrete sounder MF	1	2.0	0.7	3.0	13	20	1.5
Discrete sounder LF–HF	2	3.5	0.9	6.0	14	20	1.5
Computer processing, LF–HF	3	2.5	1.3	2.0	16	24	1.9
Full ionosonde LF–HF	4	4.5	1.4	4.0	16	24	1.9
Record only	5	7.0	1.6	3.0	19	29	2.3
Compute/record	6	8.0	2.0	2.5	21	30	2.5
			Mass Spectrometer/Low Z to Medium Z				
Selected masses	1	1	1	2	3	1	0.7
Swept mass, low Z	2	2	1.5	4	4	1.2	0.8
Computer processing, low Z	3	3.5	2.0	5	4	1.3	0.8
Computer processing, all Z	4	5.0	3.5	8	6	2.0	1.3

The options within each experiment are fairly apparent from their descriptive titles. Some comments are appropriate, however, to explain the variations in the tabular entries. For example, the basic television camera is expected to have a reasonably high scientific value and a high telemetry rate. The addition of a data processor eliminates much of the redundant data, sharply reducing the telemetry requirements but possibly losing some fine structure detail and thereby reducing its overall scientific value slightly. A two- or three-color camera is undoubtedly much more valuable, but without the data processor its telemetry requirements are enormous. Finally, an on-board recorder for multiple picture data storage is considered the ultimate option because it eliminates much of the telemetry congestion.

The life sciences experiment runs through a series of sampling techniques from an on-board sensor, through a subsatellite, to some type of lander device. Although no provision has been made to allow more than one option in each experiment, it would be possible in life sciences, for example, to combine two or more preceding options into an additional option for consideration.

The other five experiments that are proposed here have been flown numerous times on various spacecraft using various levels of sophistication. Although hard data might be available for the tabular entries of these experiment options, they have not been used here. The tabular entries were made up by the authors for purely illustrative purposes and do not describe any particular experiment.

The optimum payload selection for nine different constraint conditions is displayed in Table 2. The cost is allowed to increase steadily, whereas the other constraint parameters are incremented at intervals, much as the constraints are on a real spacecraft. The constraint *maxima were determined in advance* and not altered to fit any special requirement. It is notable that the parameter summations are usually near their maximum limit; in other words, the option selection shifts to most fully utilize the available facilities.

Cases 1, 5, 6, 7, and 8 exhibit multiple solutions. This is most likely an artifact of the simple integer nature of the constraints. In all cases the second solution is obtained by substituting one or two experiments with a small change in one or more of the constraint variables. It is especially noteworthy that the two solutions in case 5 are identical to those of case 6. The only constraint relaxed between cases 5 and 6 was the allowable cost, but apparently it was not relaxed enough to allow a new experiment to enter the solution.

The existence of multiple solutions (or even the enumeration of feasible nearby solutions) would enhance the use of the Delphi technique by providing an input to a second round of expert consensus. A good deal more information is available from the computer output. The limiting constraints are identified; in Table 2 the quantities with asterisks indicate such constraints. When no constraint is indicated as limiting, there is a little of everything left over which might provide some useful design information for altering an experiment or designing an additional experiment to fill the gap.

Finally, this technique establishes a quantitative basis for examining the incremental aspects of payload selection. A typical relationship is illustrated in Figure 1, where scientific value SV is plotted as a function of payload cost CT. Evidently, there are definite thresholds where scientific value increases sharply and plateaus where it is relatively unimproved as the cost constraint is relaxed. Similar plots are readily constructed for other combinations of variables. Under some circumstances it may be desirable to select the optimum combination at an increment maximum.

TABLE 2. Spacecraft Payload Scientific Research Optimization

	Case 1					Case 5	
	A	B	Case 2	Case 3	Case 4	A	B
Solution	CR5	CR5	LS1	LS4	LS4	LS5	LS5
Payload	RR5	PP5	CR5	CR5	CR5	CR5	CR5
Selection	MS3	MS3	RR5	MS3	PP5	PP4	PP5
			MS4		RR6	RR6	RR3
					MS4	MS4	MS4
Scientific Value SV	13.5	13.5	17.5	20.5	32.0	36.0	36.0
Cost $\Sigma\, C/CT_m$	4.4/5	4.4/5	8.9/10	14/15	19.5/20	24.3/25	23/25
Telemetry $\Sigma\, T/TM_m$	13/20	17.4/20	20/20*	13/20	21/40	23/40	37/40
Power $\Sigma\, P/PW_m$	22/25	22/25	25/25*	22/25	48/50	50/50*	45/50
Weight $\Sigma\, W/WT_m$	19/30	19/30	30/30*	23.3/30	48/60	52.5/60	45/60
Volume $\Sigma\, V/VM_m$	6.3/10	6.3/10	8.8/10	7.3/10	11.6/15	13.4/15	12.1/15

	Case 6		Case 7		Case 8		
	A	B	A	B	A	B	Case 9
Solution	LS5	LS5	LS5	LS5	TV6	TV3	TV7
Payload	CR5	CR5	TV3	TV3	LS5	LS5	LS5
Selection	PP4	PP5	CR5	CR5	CR5	CR5	CR5
	RR6	RR3	PP4	PP5	PP5	PP5	PP5
			RS6	RS5	RS6	RS5	RR5
	MS4	MS4	MS3	MS3	MS4	MS4	MS4
Scientific Value SV	36.0	36.0	45.5	45.5	47.0	47.0	51.0
Cost $\Sigma\, C/CT_m$	24.3/30	23.0/30	34.8/35	34.6/35	39.5/40	36.1/40	44.5/45
Telemetry $\Sigma\, T/TM_m$	23/40	37/40	55.5/60	57.0/60	48/60	60/60*	54/60
Power $\Sigma\, P/PW_m$	50/50*	45/50	73/75	73/75	73/75	75/75*	73/75
Weight $\Sigma\, W/WT_m$	52.5/60	45.0/60	89.8/90	89.3/90	87/90	90/90*	89/90
Volume $\Sigma\, V/WT_m$	13.4/15	12.1/15	15.9/20	15.9/20	16.6/20	16.4/20	16.2/20

A and B in cases 1, 5, 6, 7, and 8 indicate multiple solutions where the scientific value is the same. In these cases the second solution is obtained by substituting one or two experiments with a small change in one or more of the constraint variables.

TV, television camera/image processor; LS, life sciences/amino acids, bacteria; CR, cosmic rays/Geiger tubes, scintillators; PP, plasma probe/Langmuir probe, Faraday cup; RR, radio receiver/ULF, ELF, VLF, LF; RS, radio sounder/LF, MF, HF; MS, mass spectrometer/low Z to medium Z.

* Limiting constraints.

Conclusion

In conclusion, it must be emphasized that this proposed method is merely an aid to optimization of spacecraft payloads which must be augmented by prudent judgment. Application of the method clearly displays the relative importance of the constraint boundaries and demonstrates where they may be relaxed or tightened without affecting the overall mission objectives. Evidence suggests that the selection process tends to fill the spacecraft to capacity in all the constraint variables.

Utilization of this operations research method would significantly streamline the administration of payload selection. Individual proposers would be requested to identify their set of options with appropriate parameters and brief descriptions of the capability within each option. On the basis of the capability statements the scientific value could be established by a small group of impartial experts. If the option data were programed in advance, the selection process could be performed with a direct computer link in real time. This would provide the committee with the opportunity to vary constraints and scientific value estimates to determine a cluster of option combinations. Such quantitative output should speed up the decision process by eliminating many qualitative side issues. Furthermore, the procedure provides a basis for iteration between the program managers and the scientific community.

Hopefully, this method can be tested in the selection of a real payload sometime soon.

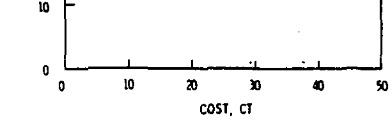

Fig. 1. The incremental relationship between scientific value and payload cost for the illustrative model.

Appendix A: Delphi Technique

There are many advantages and disadvantages to a committee of experts, some of which are the following.

Advantages

More information available
Errors can be corrected
Committees will take more chances

Disadvantages

More misinformation available
Strong social pressures bias the committee behavior
Number of arguments rather than validity tends to carry the day
Reaching agreement may become more important than accuracy
Strong personalities tend to dominate
'Winning' may tend to freeze arguments
Committee shares a common bias

In an effort to preserve the advantages and obviate the disadvantages, a method (or series of methods) of consulting the oracles has been developed and is called the Delphi method [*Dalkey*, 1969]. Its principal features are anonymity, iteration with controlled feedback, and statistical group response. More specifically, these features accomplish the following.

Anonymity. The group members are not known to each other; thus social pressures, dominance, 'winning,' etc., are obviated. An idea can be tried on its merits alone, and minds may change with no loss of face or esteem.

Iteration with controlled feedback. The group iteration is carried out via questionnaires, and thus only relevant information need be extracted from the responses and fed back for reconsideration. The respondent is only informed of the current status of the collective opinion, both majority and minority. The group does not take on its own identity and goals.

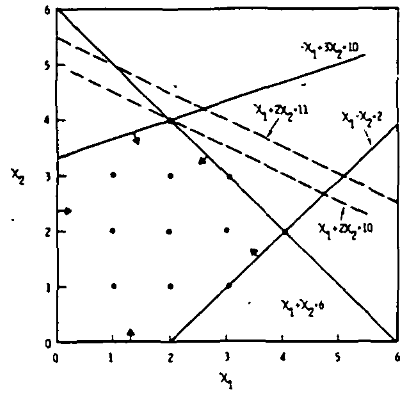

Fig. 2. Solution of a linear programing problem in a two-dimensional hyperspace of constraint parameters.

Statistical group response. Committees commonly turn out a majority opinion and perhaps a minority report. The Delphi response may include the whole spectrum of response presented in any of several common statistical measures: mean, standard deviation, quartile groups, etc.

The iteration may be continued through as many rounds as the interrogating group or manager feels useful. There have been many applications and variations of the technique carried out and reported in the literature of operations research and management science.

An excellent discussion of the method, details of procedures, 'dos and don'ts,' and references are available [e.g., *Martino*, 1972].

Appendix B: Linear Programing

The method can perhaps be illuminated with a simple example. Let us assume the following problem: maximize $x_1 + 2x_2 = Z$, subject to $x_1 + x_2 \leq 6$, $-x_1 + 3x_2 \leq 10$, $x_1 - x_2 \leq 2$, and $(x_1, x_2) \geq 0$. The set of constraints is shown in Figure 2. For simplicity, the constraints are shown as equations, and the arrows indicate the direction which the inequality would require. Clearly, the lines (including the axes) define a closed region in which each point represents a feasible set (x_1, x_2) satisfying all the constraints. The feasible integer sets are set out by the dots. The

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solution to the problem is indicated by the dashed line: $\chi_1 + 2\chi_2 = 10$, $\chi_1 = 2$, $\chi_2 = 4$. This set represents the largest value of Z which satisfies all the constraints. The line for $Z = 11$ is also shown to lie outside the feasible region. Clearly, if the slope of the function Z were different, it would be possible to have more than one integer solution to the problem, in which case the solution is said to be degenerate. Various algorithms exist to solve these kinds of problems, which get very complicated as the number of equations and variables increases.

References

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H. B. Liemohn is a Senior Research Scientist at Battelle-Northwest. His principal research studies have been in space sciences and plasma physics.

W. A. Reardon is a Senior Research Associate at Battelle-Northwest. His research interests are primarily in operations research and economics.

R. L. Engel is a Senior Research Scientist for Battelle-Northwest. He specializes in mathematical programing and large-scale computer applications.

7.1.2 Space Environment

SAI/NW-HRA-984-24
March 11, 1983

NASA SPACE STATION NEEDS, ATTRIBUTES AND OPTIONS

Summary of
Science and Applications User Survey and Mission Analysis

Conducted under
Purchase Contract CC0121
for Boeing Aerospace Company
under Prime Contract NASW-3680

SCIENCE APPLICATIONS, INC.
13400B Northrup Way #36
Bellevue, Washington 98005

NASA SPACE STATION NEEDS, ATTRIBUTES AND OPTIONS

This work was performed for the Boeing Aerospace Co. under Purchase Contract CC0121 during the period September 1982 to April 1983. The work was performed in support of a Boeing contract with NASA to study Needs, Attributes and Options of a manned Space Station to be placed in low earth orbit during the 1990's.

Technical direction was provided to SAI by Dr. Harold B. Liemohn of Boeing. The personnel assigned to this work at SAI were:

Dr. Hugh R. Anderson (Principal Investigator)
Dr. Peter J. Hendricks (Alternate PI)
Dr. Gilbert R. Stegen (Division Manager)
Dr. Robert L. Loveless (Scientist)
Dr. Robin D. Muench (Scientist)

all of the Bellevue, Washington office.

The life sciences analysis work was performed by:

Dr. John Wilson
Ms. Monica Dussman

of the SAI/La Jolla office, with support from Dr. S. Gorney and members of Bio-Med.

Prior to initiation of the contract with Boeing, SAI assisted in preparation of Boeing's proposal to NASA.

1) The first task performed under the contract was to mail a user requirements survey to scientists in the fields of space plasma physics, astrophysics, ocean and land remote sensing, and some other branches of physics. In order to increase the probability of a response, the inquiry was sent only to individuals known to the SAI staff. The inquiry requested either general comments on the Space Station or specific experiments described on a NASA-supplied form. This mailing was begun in late September, with a follow-up in early January; answers were received through January. Copies of the responses follow. A summary is noted below:

Inquiries sent: 139
Specific experiments described: 28
Other responses, written or oral: 19

Of the 19 "other" responses, two were rather negative about the Station; we must assume that some of the non-respondents have negative views also. Some of these have already participated in NASA studies of the Station. Others feel that NASA should use the Shuttle/Spacelab for science as it promised before soliciting support for a Station.

Copies of all responses were supplied to Boeing as received.

2) Other tasks that have been performed are:

- Arranged a visit to Los Alamos for Boeing and SAI personnel to discuss uses of Space Station. Two SAI staff members attended this meeting.

- Provided a library of documents and publications prepared by NASA and other agencies concerning scientific uses of Space Station and Platform.

- Provided in late October a summary of scientific uses and requirements as part of the Boeing midterm presentation to NASA. An SAI staff member attended this briefing.

- In response to a request from Boeing in late October, organized and performed a user survey in the life sciences, concentrating on human medicine. This work was begun at the beginning of December; a report and oral presentation were given to Boeing on 13 January by Dr. John Wilson and others. A total of 41 potential investigators were contacted. Four specific experiments were described.

- Pursuant to a request on 16 December, prepared a table of experiment categories, instruments, and interface requirements. An evaluation of these experiments' scientific value was also made. A first draft of this was completed 27 December and a final copy was transmitted to Beoing on 3 January 1983. This was based on responses to the user survey and on documentation provided by NASA.

- Submitted draft material by 14 February 1983 for use in Volume 2 of the Boeing final report.

- Completed editorial comments on the final report material on 11 March.

7.1.2.1 Space Environment Bibliography

BIBLIOGRAPHY

Courtesy of SAI

SPACE PLATFORM/SPACE STATION
PAYLOAD REQUIREMENTS AND ACCOMMODATIONS
DOCUMENT LIBRARY

S A I / NORTHWEST
13400B SUITE 36 NORTHRUP WAY
BELLEVUE, WASHINGTON 98005

TABLE OF CONTENTS

USE OF THE LIBRARY

A. The Document List

The documents are sequentially numbered in alphabetical order. A numbering scheme using tens instead of single digits was used to facilitate later additions. Each document in the library is labeled with its sequence number and stored in a magazine file with the appropriate sequence numbers on the outside. Some of the larger volumes are tabbed with colored metal separators to indicate areas of interest; however, most of the volumes are small enough or general enough to make this tabbing unnecessary.

B. The Keyword Catalog

The keyword catalog consists of a list of keywords and the documents associated with each. Where appropriate, page numbers are mentioned after the title. In most cases, the entire document deals with the related subject and the volume Table of Contents provides the location of more specific information.

C. The Acronym Glossary

The acronym glossary provides a table of definitions for the acronyms used in the reference library which are not explained in NASA Reference Publication 1059, titled "Space Transportation System and Associated Payloads: Glossary, Acronyms, and Abbreviations."

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7.1.2.2 Space Sciences Researchers

SPACE SCIENCE RESEARCHERS

Assembled by SAI

Tabulated January 1983

SAI/NW-HRA-984-05
September 28, 1982

NASA SPACE STATION
NEEDS, ATTRIBUTES AND OPTIONS

USER REQUIREMENTS SURVEY

conducted for

BOEING AEROSPACE CO.
SEATTLE, WA

by

SCIENCE APPLICATIONS, INC.
13400B NORTHRUP WAY #36
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SPACE STATION NEEDS, ATTRIBUTES AND OPTIONS

BACKGROUND OF SPACE STATION STUDIES

- The idea of a large, multipurpose satellite in earth orbit has been discussed for a number of years.
- NASA has conducted studies of an unmanned platform and a manned station in recent years. Either of these would be modular, assembled in orbit, and serviced by the Shuttle.
- Now NASA has decided to develop a Manned Space Station to be assembled in low earth orbit with inclinations from equatorial to polar possible. It is hoped that design can begin in 1985, and launch and assembly begin in the 1990's.*
- The Station will generate power, handle relatively large amounts of data for analysis on board or transmission to the ground, and have facilities for extra-vehicular activity.
- To derive the architecture of the Station and determine the range of uses for it, NASA wishes to discuss the program with potential users in the following areas:
  - Scientific investigations in all areas;
  - Applications: remote sensing, etc.
  - Commercial;
  - Technology development;
  - National security;
  - Operations: assembly and injection of geosynchronous or planetary spacecraft; servicing free-flyers, etc.
- Identified users may have the opportunity to assist on a continuing basis in defining and developing a station.

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*A description of this program may be found in Science 217, 1018-1021 (September 10, 1982).

SPACE STATION MISSION ANALYSIS

- NASA has commissioned eight companies to identify potential users of a manned Space Station in low earth orbit and to study the impact of their requirements on Station architecture.

- Boeing Aerospace Corporation is one of the eight companies. They have contracted with SAI/Northwest to assist in identifying scientific uses of the Station as well as certain applied and commercial uses.

- We plan to discuss the Space Station with key investigators in each relevant technical area.

- We invite you to contribute to our study by providing one or more of the following:

  - Any general comments that you care to make about the future space program and the possible role of a Space Station in it.

  - Names of colleagues and associates who might be interested in talking with us.

  - Descriptions of specific experiments or programs that you would like to carry out that would benefit from or use a Space Station.

- If you have a specific use we need to identify the requirements it would place on a Station. Areas of impact include mass, volume, power, data processing, and crew support.

- To enable you to provide this information we include a list of specific questions in written form. You can answer them in a subsequent telephone interview or in writing.

SPACE STATION MISSION ANALYSIS STUDY

- A form supplied by NASA is attached to summarize requirements of space station missions.

- The first page provides general mission information. Please fill out as completely as possible.

- The second and third pages will allow you to indicate specific mission requirements. Please fill out those sections that may have a significant impact on your experiments.

- In addition, we would like comments on the effectiveness of manned space missions for scientific investigations in your field and specific information on possible crew involvement in your experiments.

MISSION NAME	CODE	TYPE
CONTACT (Name address, phone)		
STATUS		

MISSION NAME

CODE

CONTACT (Name address, phone)

STATUS

☐ Operational

☐ Approved

☐ Planned

☐ Candidate

☐ Opportunity

Year of first flight ________

Number of missions ________

OBJECTIVE

TYPE

Science and Applications

☐ Astrophysics
☐ Communications
☐ Earth and Planetary Exp.
☐ Environmental Observations
☐ Life Sciences
☐ Materials Processing

Commercial

☐ Earth and Ocean Operations
☐ Communications
☐ Materials Processing
☐ Industrial Research

National Security

☐ Research and Development
☐ Operational

Technology Development

☐ Generic
☐ Flight Missions
☐ Operations
☐ Basic Physics and Chemistry

DESCRIPTION

ORIGINAL PAGE IS
OF POOR QUALITY

ORBIT CHARACTERISTICS

Apogee, km ________ Perigee ________ Tolerance ± ________

Inclination, deg ________ Tolerance ± ________

Argument of perigee, deg ________ Ephemeris accuracy ________

Synchronization ☐ None ☐ Earth ☐ Sun ☐ Other ________

POINTING(Real Time)

View direction ☐ Inertial ☐ Solar ☐ Earth ☐ Other ________

Pointing accuracy ________ Field of view ________

Specific targets Stability angle ________

DATA/COMMUNICATIONS

Monitoring requirements ☐ None ☐ Realtime ☐ Offline ☐ Other

Data rate ________ Frequency, Hz ________ Bandwidth, Hz ________

☐ Onboard data processing Data storage, kB ________

☐ Encryption/Decryption required

POWER

	Power, W	Duration, hr
Operating	________	________
Standby	________	________
Peak	________	________

Voltage, V ________ Frequency, Hz ________

Duty Cycle Description

ORBIT TRANSFER STAGE (IF KNOWN)

☐ PAM-A ☐ PAM-D ☐ IUS

THERMAL

Type of concept ______

Temperature, deg C   Operational min ______ max ______ Peak ______

Cryogenic   Load ______ Temperature ______ Duration ______

Heat Rejection, W   Operational ______ Peak ______

CREW REQUIREMENTS

Estimated crew size   Permanent ______ Service ______ EVA ☐ Yes ☐ No

Manhours/mission ______ Average time between visits, days ______

Skills required ______

PHYSICAL CHARACTERISTICS

Launch mass, kg ______ Deployed mass ______ Expendables ______

Length, m   Launch w/OTV ______ Undeployed ______ Deployed ______

Diameter, m   Launch ______ Undeployed ______ Deployed ______

Center of gravity location, m   X ______ Y ______ Z ______

SPECIAL CONSIDERATIONS/CLARIFICATIONS

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7.1.2.3 Space Environment User Data Forms

PAYLOAD ELEMENT NAME
PARTICLE BEAM GENERATOR

CODE
BACX0001

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO DEVELOP A HIGH-ENERGY CHARGED PARTICLE BEAM

DESCRIPTION
BECAUSE OF THE LOW DENSITY OF GAS IN SPACE, IT IS POSSIBLE TO USE THE REGION TO ACCELERATE PARTICLES IN A LINEAR OR CIRCULAR PATTERN AS IS DONE ON THE EARTH'S SURFACE. WITH A SPACE STATION TO PROVIDE POWER FOR THE ACCELERATION OF IONS, ONE COULD ACHIEVE HIGH ENERGIES. THE APPLICATIONS ARE IN BASIC HIGH-ENERGY PHYSICS RESEARCH AND PARTICLE BEAM WEAPONS. (CONTACT DR. LEON LEDERMAN, DIRECTOR OF FERMILAB, CHICAGO, IL).

ORIGINAL PAGE IS OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	3000	0.10
Standby		
Peak		
Voltage, V		Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS
Monitoring Requirements:
(X) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 3.00 meters Width: 2.00 meters Height: 2.00 meters (Stowed)
Length: 3.00 meters Width: 2.00 meters Height: 2.00 meters (Deployed)
Launch mass, kg: 1000 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA (X) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
AN ARRAY OF LARGE BENDING MAGNETS EACH WITH ITS OWN POWER SUPPLY.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number:

DESCRIPTION

BECAUSE OF THE LOW DENSITY OF GAS IN SPACE, IT IS POSSIBLE TO USE THE REGION TO ACCELERATE PARTICLES IN A LINEAR OR CIRCULAR PATTERN AS IS DONE ON THE EARTH'S SURFACE. WITH A SPACE STATION TO PROVIDE POWER FOR THE ACCELERATION OF IONS, ONE COULD ACHIEVE HIGH ENERGIES. THE APPLICATIONS ARE IN BASIC HIGH-ENERGY PHYSICS RESEARCH AND PARTICLE BEAM WEAPONS. (CONTACT DR. LEON LEDERMAN, DIRECTOR OF FERMILAB, CHICAGO, IL).

Item Dry Weight: pounds Volume: cubic feet

Structural Weight (includes typical "mechanical" items listed below): pounds

Design Complexity:

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description: Analog %
Digital %
Power Supplies %
Other %

Manufacturing Complexity for Electronic Items:

Weight of the Circuit Board and Electronics Mounted on it: pounds

Material Used for the Enclosure: Machine Casting?

Of the electronics weight, what % is off-the-shelf?

Of the sturctural weight, what % is off-the-shelf?

Manufacturing Degree of Automation
Electronics ( ) Low ( ) Medium ( ) High
Mechanical ( ) Low ( ) Medium ( ) High

Is the item Hardened?

PAYLOAD ELEMENT NAME
SPACE PLASMA PHYSICS

CODE
BACX0003

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO DIAGNOSE THE EARTH'S UPPER ATMOSPHERE, IONOSPHERE AND MAGNETOSPHERE THROUGH ACTIVE STIMULATION WITH WAVES, PARTICLES, AND OPTICAL SOURCES ON THE STATION AND ONE OR MORE SUBSATELLITES.

DESCRIPTION
THE SPACE STATION WOULD SERVE AS THE PLATFORM FOR POWERFUL WAVE, PARTICLE AND OPTICAL SOURCES AS WELL AS FOR DIAGNOSTIC INSTRUMENTS SUCH AS WAVE RECEIVERS, PARTICLE DETECTORS AND OPTICAL IMAGES. SUBSATELLITES ARE USED TO DIAGNOSE IN SITU AND REMOTE EFFECTS OF THESE SIMULATIONS. INITIALLY A SATELLITE W/O PROPULSION COULD BE LAUNCHED FROM THE SHUTTLE/SPACELAB, USED ON ORBIT 6 MONTHS, THEN RETRIEVED BEFORE ORBITAL DECAY. LATER A SATELLITE WITH SOME ORBIT-CHANGE CAPABILITY COULD BE UTILIZED FOR EXTENDED PERIODS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg 90.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 2.00 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	75	3.00
Standby	15	(X) Continuous
Peak	100	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	-20	Maximum	60
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	75	Maximum	100
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 75 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

PAYLOAD ELEMENT NAME
ATMOSHERIC SAMPLER

CODE
BACX0004

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 2

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO PERFORM A WORLD-WIDE SURVEY OF THE VARIABLE ATMOSPHERIC PARTICULATES USING VISIBLE AND INFRARED LIDAR.

DESCRIPTION
MULTISTATIC-MULTISPECTRAL LIDAR; AN ACTIVE ATMOSPHERIC PROBE USED TO DETERMINE THE COMPOSITION, STRUCTURE AND MAGNITUDE OF THE ATMOSPHERIC AEROSOL CONTENT BY USING LASERS IN A MANNED ORBITING LABORATORY AND A SERIES OF SMALL DETECTORS AT VARIOUS ANGLES TO PRODUCE A WORLD-WIDE VERTICAL PROFILE OF THE ATMOSPHERIC PARTICULATE COMPONENT (IF IN ORBIT SIMILAR TO LANDSAT). POSSIBLE LASERS WOULD BE A NEODYMIUM YAG AT 1.06 UM AND A FREQUENCY-DOUBLED NEODYMIUM YAG AT 0.53 UM.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg 80.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s .

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 0.10 Field of View (deg) 30.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	500	1	
Standby			(X) Continuous
Peak			
Voltage, V		Frequency, Hz	

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None   ( ) Realtime   (X) Offline   ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS):   Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog   (X) Digital   Hours/Day
Film (Amount):   Voice (Hours/Day):
Live TV (Hours/Day):   Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit)   Downlink command rate:
Recording Rate (KBPS)   Downlink Frequency (MHz):

THERMAL
(X) Active   ( ) Passive
Temperature, deg C   Operational Minimum   Maximum
Non-operational Minimum   Maximum
Heat Rejection, w   Operational Minimum   Maximum
Non-operational Minimum   Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location   ( ) Internal   (X) External   ( ) Remote
Equipment ID/Function   (X) Pressurized   ( ) Unpressurized
L, m: 1   W, m: 1   H, m: 1   Stowed
L, m: 1   W, m: 1   H, m: 1 0   Deployed
Launch mass, kg: 75   Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g)   min: E+00   max: E+00

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CREW REQUIREMENTS
Crew Size   Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No   Reason   Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days   Consumables, kg
Returnables, kg   Man hours
Configuration Changes: Interval, day   Man/Hours Required
Deliverables, kg   Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
NEED AT LEAST FOUR ADDITIONAL SENSORS PLACED IN THE SAME ORIT AS THE SPACE STATION. THEY SHOULD HAVE TRANSPONDERS FOR PERIODIC READOUT OF LASER-SCATTERED DATA. DISTANCE BETWEEN SENSORS AND SPACE STATION SHOULD BE ABOUT 500 KM.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
ATMOSPHERIC GEN CIRC EXP (AGCE)

CODE
BACX0010

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

CONTACT

Name WILLIAM W. FOWLIS
Address FLUID DYNAMICS BRANCH, A
SPACE SCIENCE LABORATORY
NASA/GEORGE C MARSHALL S
MARSHALL SPACE FLIGHT CE

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 0

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
THE AGCE CAN BE CONSIDERED A MODEL OF LARGE-SCALE TERRESTRIAL ATMOSPHERIC CIRCULATION.

DESCRIPTION
THE AGCE IS SIMILAR TO THE GFFC IN THAT IT CONSISTS OF TWO CONCENTRIC HEMISPHERES BUT WITH A STABLE RADIAL TEMPERATURE GRADIENT AND AN UNSTABLE LATITUDINAL TEMPERATURE GRADIENT IMPOSED. IT IS IN THE DESIGN STAGE CONSTRUCTION NOT YET STARTED. IT IS INTENDED THAT BOTH THE GFFC AND AGCE BE FLOWN ON MANY SUBSEQUENT SPACELAB FLIGHTS. "QUIET" PERIODS IN ORBIT ARE NECESSARY AS DISTURBING ACCELERATIONS MUST BE SMALL.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg . Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s .

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	225	1
Standby		
Peak	545	
Voltage, V		Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 110 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
SPACE ENVIRONMENT MONITORING

CODE
BACX0011

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
Name R.N. GRUBB R431
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ERL/NOAA
U.S. DEPT OF COMMERCE
BOULDER, CO 80303

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
ROUTINE SOLAR OBSERVATION FOR THE SPACE ENVIRONMENT SERVICE CENTER (SESC).

C-2

DESCRIPTION
THE SESC IS THE NATONAL AND INTERNATONAL CENTER FOR THE PROVISION OF REAL TIME SPACE ENVIRONMENTAL MONITORING AND FORECASTING SERVICES. THESES ARE UTILIZED BY A WIDE SPECTRUM OF GOVERNMENT AND NONGOVERNMENT ACTIVITIES WHICH ARE AFFECTED BY OUR SOLAR TERRESTRIAL ENVIRONMENT. CURRENT REAL TIME SOLAR IMAGE OBSERVATION IS BY A WORLD-WIDE NETWORK OF GROUND OBSERVATORIES AND COMMUNICATIONS. THE PROPOSED SOLAR IMAGER SYSTEM ON THE SPACE STATION COULD PROVIDE HIGH QUALITY DATA MORE CONTINUOUSLY AND PERMIT OBSERVATION AT OTHERWISE UNACCESSIBLE WAVELENGTHS THROUGH THE GROUND NETWORK.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial (X) Solar ( ) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 1.00 Field of View (deg) 1.00
Pointing Stability (Jitter), arc-sec/sec 5.00
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	300	2.00
Standby		
Peak		

(X) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 75 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size

Skills (See Table B)

Task Assignments

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

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Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
HIGH RESOLUTION DOPPLER IMAGER

CODE
BACX0014

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name DR. P.B. HAYES/T.L. KILLEEN
Address SPACE PHYSICS RESEARCH L
THE UNIV OF MICHIGAN
ANN ARBOR, MI 48109

Telephone 313/764-7220

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational (X) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1988 Number of Flights Duration of Flight, Days

OBJECTIVE
MEASURE VECTOR WIND FIELD IN UPPER TROPOSPHERE, STRATOSPHERE AND MESOSPHERE.

DESCRIPTION
TRIPLE ETALON FABRY-PEROT INTERFEROMETER WITH LIMB SCANNING OPTICS.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 1000 Perigee, km 35786 Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.01 Field of View (deg) 0.01
Pointing Stability (Jitter), arc-sec/sec 0.01
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	100	24.00	
Standby	25	24.00	( ) Continuous
Peak			
Voltage, V		Frequency, Hz	

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	-30	Maximum	-10
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	80	Maximum	
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 100 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	days	Consumables	kg
	Returnables	kg	Man hours required	
Configuration Changes:	Interval	days	Man-Hours Required	
	Deliverables	kg	Returnables	kg

SPECIAL CONSIDERATIONS/See instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)
Mass:	kg					

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

PAYLOAD ELEMENT NAME
LARGE ARRAY DOPPLER IMAGER

CODE
BACX0015

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
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THE UNIV OF MICH
ANN ARBOR, MI 48109

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
ULTRA-HIGH RESOLUTION SPECTROSCOPY OF NATURAL, ARTIFICIAL AND ASTRONOMICAL EMISSIONS.

DESCRIPTION
1 METER DIAMETER TRIPLE ETALON FABRY-PEROT INTERFEROMETER.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.01 Field of View (deg) 0.5
Pointing Stability (Jitter), arc-sec/sec 0.01
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	200	24.00
Standby	100	24.00
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None (X) Realtime ( ) Offline ( ) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

( ) On-Board Data Processing Required

Description:

Data Types: ( ) Analog ( ) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	15	Maximum	25
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	7200	Maximum	
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote

Equipment ID/Function ( ) Pressurized ( ) Unpressurized

Length: meters Width: meters Height: meters (Stowed)

Length: meters Width: meters Height: meters (Deployed)

Launch mass, kg: 1000 Return mass, kg:

Consumable Types

Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS

Crew Size

Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval days Consumables kg

Returnables kg Man hours required

Configuration Changes: Interval days Man-Hours Required

Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

PAYLOAD ELEMENT NAME
SPACE PLASMA PHYSICS (SPACELAB 6

CODE
BACX0025

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 26

CONTACT
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TORONTO, CANADA M3J 1P3

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 3

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights 2 Duration of Flight, Days

OBJECTIVE
TO MEASURE WIND, TEMPERATURE AND EMISSION RATE FIELDS FOR ATMOSPHERIC EMISSIONS IN THE ALTITUTDE RANGE 80-300 KM, PARTICULARLY SMALL SCALE WIND PATTERNS IN AND AROUND AURORAL FORMS.

DESCRIPTION
THE WAMDII (WIDE ANGLE MICHELSON DOPPLER IMAGING INTERFEROMETER) CONSISTS OF A CCD CAMERA PLACE BEHIND A FIELD-WIDENED MICHELSON INTERFEROMETER. THE PATH DIFFERENCE IS FIXED AT ABOUT 5 CM, BUT A PIEZOELECTRICALLY CONTROLLED MIRROR CAN BE MOVED THROUGH ONE ORDER. THREE IMAGES ARE TAKEN, AT DIFFERENT MIRROR POSITIONS CORRESPONDING TO 90 DEG OF PHASE SHIFT. THIS PROVIDES ENOUGH INFORMATION TO DERIVE THE APPARENT LINE-OF-SIGHT ATMOSPHERIC VELOCITY, THE APPARENT TEMPERATURE AND THE INTENSITY OF THE EMITTING REGIONS, OI 5577 AND 6300 A, 0+ 7320A, 02ATM (0,0) AND PERHAPS OH, COVERING A WIDE ALTITUDE RANGE.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg 90.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 0.50 Field of View (deg) 5.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	500	.50	
Standby	100		(X) Continuous
Peak	260		
Voltage, V	28	Frequency, Hz	

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required

Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive
Temperature, deg C Operational Minimum 22 Maximum 28
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 2 W, m: 1 H, m: 1 Stowed
L, m: 2 W, m: 1 H, m: 1 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS

Crew Size

Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

IN PRESENT DESIGN, BAFFLE IS FIXED TO OPTICS UNIT BUT FOR THE SPACE STATION IT COULD BE ATTACHED IN ORBIT. IT IS ALSO POSSIBLE THAT THE BAFFLE SHOULD HAVE ONE AXIS OF ROTATION TO PROVIDE POINTING. THERMAL REQUIREMENTS VARY DEPENDET ON ENVIRONMENT, BUT FAIRLY TIGHT THERMAL CONTROL REQUIRED. IMAGES TAKEN UP TO 3/SEC, & BOTH DAY & NIGHT VIEWING DESIRED.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
PLASMA PHYSICS SPACE

CODE
BACX0026

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 26

CONTACT
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UTAH STATE UNIVERSITY
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
UTILIZE SPACE STATION TO PERFORM ACTIVE AND PASSIVE PLASMA PHYSICS EXPERIMENTS IN THE EARTH'S ATMOSPHERE, SUCH AS 1) EXPERIMENTAL MAGNETOSPHERIC MODELING, 2) E-BEAM EXPERIMENTS, 3) PLASMA CONTAINMENT, 4) TETHERED CURRENT COLLECTORS, 5) ROUTINE GEOPHYSICAL MONITORING, 6) TESTING FACILITY FOR PLASMA INSTRUMENTATION DEVELOPMENT.

DESCRIPTION
IN ORDER TO SUPPORT BOTH ACTIVE AND PASSIVE PLASMA PHYSICS EXPERIMENTS WE NEED THE FACILITY FOR HAVING A SOPHISTICATED DEPLOYABLE MANIPULATING SYSTEM TO REMOVE COMPONENTS OF THE PLASMA PHYSICS EXPERIMENTS AWAY FROM THE SPACE STATION - DISTANCE OF THIS DEPLOYMENT OF THE ORDER OF AT LEAST ONE SPACE STATION EQUIVALENT RADIUS. THIS SYSTEM SHOULD BE CAPABLE OF DEPLOYING INSTRUMENTS BOTH UPSTREAM AND DOWNSTREAM RELATIVE TO THE RAM DIRECTION AND THE DEPLOYED TABLE TO MOUNT THE INSTRUMENTS SHOULD BE CAPABLE OF INDEPENDENT MANEUVERING AT WHATEVER LOCATION THE ARM IS SITUATED. IDEALLY, SHOULD HAVE FACILITY TO DEPLOY FREE-FLYING SUBSATELLITES.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	2.5
Standby	100	(X) Continuous
Peak	500	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 2000 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
SPLIT LANGMUIR PROBE (SLUPP)

CODE
BACX0027

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 26

CONTACT
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO USE THE UNIQUE CAPABILITY OF A SPACE STATION FOR SUSTAINED EXPERIMENTAL AND INSTRUMENT INTERACTION TO ACCELERATE DEVELOPMENT OF NEW GENERATIONS OF SPACE PLASMA DIAGNOSTICS.

DESCRIPTION
ONE EXAMPLE OF A PLASMA DIAGNOSTIC INSTRUMENT DEVELOPMENT PROJECT WHICH COULD BENEFIT FROM THE SPACE STATION IS THE SPLIT LANGMUIR PROBE (BERING ET AL. 1973, 1975; BERING, 1974; BERING & MOZER, 1975). THIS INSTRUMENT IS ONE WHOSE DEVELOPMENT WAS NEVER COMPLETED BECAUSE OF THE DIFFICULTY AND EXPENSE OF TESTING PROBLE GEOMETRICS ONE ROCKET FLIGHT AT A TIME. DEVELOPMENT OF THIS INSTRUMENT AND MANY OTHER GEOMETRY-DEPENDENT PLASMA DIAGNOSTIC INSTRUMENTS COULD BE VERY MUCH ACCELERATED BY HAVING AN EXPERIMENTER, TECHNICAL AND A SUPPLY OF RAW MATERIALS IN THE STATION AND ALLOW THEM TO TEST AND MODIFY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	50	.50
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 20 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size

Skills (See Table B)

Task Assignments

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
NOTE 2 CREW REQUIRED FOR DURATION OF EXPERIMENT, WHICH MAY WELL BE SHORTER THAN DURATION OF MISSION IF BY MISSION YOU MEAN LIFE OF STATION.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
IONOSPHERE/ATMOSPHERE MONITOR

CODE
BACX0028

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 26

CONTACT
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MEASURE ATMOSPHERE/IONOSPHERE DYNAMIC PROPERTIES TO DETERMINE SOLAR CYCLE DEPENDENCIES AND NATURAL AND MAN-MADE PERTURBATIONS.

DESCRIPTION
INSTRUMENT PACKAGE MOUNTED TO A FORWARD-LOOKING GROUND PLANE - CONSISTING OF ION DRIFT METER, ION RETARDING POTENTIAL ANALYZER, NEUTRAL WIND MASS SPECTROMETER, RETARDING NEUTRAL MASS SPECTROMETER, AND LANGMUIR PROBE.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 950 Perigee, km 250 Tolerance + 10 - 10
Inclination, deg Tolerance + 5 - 5
Nodal Angle, deg Ephemeris Accuracy, m 2
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 2.00 Field of View (deg) 3.00
Pointing Stability (Jitter), arc-sec/sec -0.10
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day	
Operating	50		
Standby	50		( ) Continuous
Peak	50		
Voltage, V	-28	Frequency, Hz	0

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive
Temperature, deg C Operational Minimum -10 Maximum 50
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 70 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

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CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA (X) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

GROUND PLANE TO LOOK ALONG VOCAL VELOCITY VECTOR. BODY MOUNTED INSTRUMENT PACKAGE. INSTRUMENTS SHOULD BE CONTAINED IN ENVELOPE DESCRIBED BY CYLINDER APPROX. 1.0 M IN DIAMETER BY APPROX. 0.6 M IN LENGTH. THE CIRCULAR FACE SHOULD LOOK ALONG THE LOCAL VELOCITY VECTOR. GROUND PLANE DIAMETER SHOULD BE GREATER THAN 1.0 M.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
ACTIVE CAVITY RADIOM SOLAR IRRAD

CODE
BACX0030

CONTACT

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TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
(X) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MONITOR SOLAR TOTAL AND SPECTRAL IRRADIANCE OVER SOLAR MAGNETIC CYCLE-
DETECTION OF SOLAR VARIABILITY-CLIMATE LINKS

DESCRIPTION
THE RELATIONSHIP BETWEEN EARTH WEATHER AND CLIMATE AND SOLAR VARIATION IN TOTAL AND SPECTRAL IRRADIANCE MAY BE A SIGNIFICANT FACTOR IN DETERMINING THE NATURE OF THE EARTH'S ENVIRONMENT. THE OTHER SIDE OF THE RESEARCH IS TO UNDERSTAND SOLAR PHYSICAL PROCESSES BETTER TO ARRIVE AT A PREDICTION CAPABILITY FOR THE RADIATION IMPACT OF SOLAR MAGNETIC ACTIVITY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial (X) Solar ( ) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg) 5.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	20	1
Standby	0	
Peak	25	
Voltage, V	28	Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum 5 Maximum 55
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 30 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA (X) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
TWO IDENTICAL INSTRUMENTS (ACTIVE CAVITY RADIOMETER IRRADIANCE MONITORS) WOULD BE EXCHANGED AT 1-YEAR (MAX) INTERVALS. SHUTTLE WOULD LEAVE FRESHLY REFURBISHED ACR AFTER COMPARING THE TWO AND RETURN OTHER FROM SPACE STATION FOR REFURBISHMENT/RECALIBRATION.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
PARTICLE ENERGY MONITOR

CODE
BACX0031

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 26

CONTACT
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 2

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
GLOBAL PARTICLE ENERGY MONITOR (GPEM)

DESCRIPTION
GPE WOULD BE A DERIVATIVE FROM THE PEM INSTRUMENT ON UARS. IT CONSISTS OF A MAGNETOMETER, AN ARRAY OF ENERGETIC PARTICLE SENSORS UP TO 5 MEV, AN ARRAY OF LOW ENERGY SENSORS DOWN TO <1 EV (I.E. COMPLETE COVERAGE FROM < 1 EV TO > 5 MEV), AN ELECTROSTATIC 3D DRIFTMETER AND A SPECTROMETER X-RAY IMAGER.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg 60.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 0.50 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	67	.50	
Standby	10		( ) Continuous
Peak	67		
Voltage, V	22	Frequency, Hz	

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive
Temperature, deg C Operational Minimum -10 Maximum 30
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 2 W, m: 1 H, m: 2 Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 175 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS

Crew Size

Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

1) AXIS RADIATOR MUST VIEW BLOCK SPACE, 2) ZEPS MUST HAVE A 2 STERADIAN CLEAR FOV (ZENITH HEMISPHERE)
3) NEPS MUST HAVE A 75 DEG CONICAL CLEAR FOV TOWARD NADIR.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
FIELD LINE MAPPING

CODE
BACX0039

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

CONTACT
Name HUGH R. ANDERSON
Address SCIENCE APPLICATIONS, IN
13400B NORTHRUP WAY #36
BELLEVUE, WA 98005

Telephone (206) 747-7152

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 2

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO MEASURE AND UNDERSTAND THE PROPAGATION OF BEAMS OF ENERGETIC CHARGED PARTICLES THROUGH THE MAGNETOSPHERE.

DESCRIPTION
THE SPACE STATION (PSS) CARRIES ION AND ELECTRON ACCELERATORS ABLE TO ACCELERATE UP TO 1 A TO 100 KV. AN UPGRADED VERSION FOR THE SECOND FLIGHT WILL ACCELERATE ELECTRONS TO 1 MEV. VARIOUS ION SPECIES MUST BE USED. THE EFFECTS ARE DETECTED AT A MANEUVERABLE SUBSATELLITE CARRYING DIAGNOSTIC INSTRUMENTS, AND BY REMOTE SENSORS (X-RAY, RADAR) ON PSS. THE IONS MAY BE DETECTED BY THE EML SATELLITE OF OPEN.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	2500	0.50	
Standby	100	8.00	( ) Continuous
Peak			
Voltage, V	28	Frequency, Hz	

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 2.0 W, m: 2.0 H, m: 2.0 Stowed
L, m: 2.00 W, m: 2.00 H, m: 2.00 Deployed
Launch mass, kg: 600 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
S.S. INCOHERENT SCATTER RADAR

CODE
BACX0054

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name LEWIS H DUNCAN
Address UNIVERSITY OF CALIF
LOS ALAMOS NATL LAB
ESS-7 MS D466
LOS ALAMOS, NM 87545

Telephone 505/667-7702

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO DEVELOP AND OPERATE FROM NEAR-EARTH SPACE A UHF INCOHERENT SCATTER RADAR FOR REMOTE-SENSING OF THE EARTH'S UPPER ATMOSPHERE

DESCRIPTION
THE PROPOSED MISSION WILL PROVIDE WORLDWIDE OBSERVATIONS OF UPPER ATMOSPHERIC MORPHOLOGY AND DYNAMICS THROUGH THE MONITORING OF IONOSPHERIC ELECTRON DENSITIES, ELECTRON AND ION TEMPERATURES, IONOSPHERIC DRIFTS AND BACKGROUND WINDS, ION COMPOSITION, AND PLASMA WAVE TURBULENCE. INCOHERENT SCATTER RADAR HAS THE ADVANTA OVER IN-SITU PASSIVE PLASMA DIAGNOSTICS IN THAT IT PROVIDES HIGH-RESOLUTION OBSERVATIONS OF THE AMBIENT AEROSPACE ENVIRONMENT WELL BEYOND THE LOCAL REGION DISTURBED BY THE INSTRUMENTED VEHICLE. THE RADAR CAN BE USED BOTH FOR LONG-TERM GLOBAL OBSERVATIONS OF THE AMBIENT UPPER ATMOSPHERIC BEHAVIOR, AND FOR SPECIFIC DIAGNOSTIC SUPPORT TO ACTIVE SPACE PLASMA PHYSICS EXPERIMENTS SUCH AS HF RADIOWAVE MODIFICATION OF THE IONOSPHERE, WAVE AND CHEMICAL INJECTION EXPERIMENTS, AND BEAM-PLASMA INTERACTION STUDIES.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC
Power, W Duration, Hrs/Day

Operating
Standby ( ) Continuous
Peak
Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
POWER, CAPACITOR BANK, HEAT DISSIPATION, AND ANTENNA SIZE REQUIREMENTS, AS WELL AS PROBABLE FREQUENT MAN-MACHINE INTERFACING NEEDS, DETERMINE THIS RADAR TO BE NECESSARILY A SPACE STATION MISSION.

PAYLOAD ELEMENT NAME
S.S. DIGITAL HF RADAR

CODE
BACX0055

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name PAUL E. ARGO
Address UNIVERSITY OF CALIFORNIA
LOS ALAMOS NATIONAL LAB
ESS-7 MS D466
LOS ALAMOS, NM 87545

Telephone 505/667-8355

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO DEVELOP AND OPERATE FROM NEAR-EARTH SPACE ON HF DIGITAL TOPSIDE IONOSONDE/HF RADAR.

DESCRIPTION
THE PROPOSED MISSION WILL PROVIDE WORLDWIDE OBSERVATIONS OF UPPER ATMOSPHERIC/IONOSPHERE MORPHOLOGY AND DYNAMICS THROUGH THE MONITORING OF TOPSIDE IONOSPHERIC ELECTRON DENSITIES AND STRUCTURE MOTIONS. HF IONOSONDES HAVE THE ADVANTAGE OVER IN-SITU PASSIVE PLASMA DIAGNOSTICS IN THAT THEY PROVIDE HIGH-RESOLUTION OBSERVATIONS OF THE AMBIENT SPACE ENVIRONMENT WELL BEYOND THE LOCAL REGION DISTURBED BY THE INSTRUMENTAL VEHICLE. THE IONOSONDE CAN BE USED BOTH FOR LONG TERM GLOBAL OBSERVATIONS OF THE AMBIENT TOPSIDE IONOSPHERIC BEHAVIOR AND FOR SPECIFIC DIAGNOSTIC SUPPORT TO ACTIVE SPACE PLASMA PHYSICS EXPERIMENTS. IN ADDITION, GLOBAL SURVEILLANCE COVERAGE OF THE IONOSPHERE IS WITHIN THE SCOPE OF SUCH A SPACE-BORNE IONOSONDE HF RADAR.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating		
Standby		( ) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
ANTENNA SIZE REQUIREMENTS, AS WELL AS POSSIBLE FREQUENT MAN-MACHINE INTERFACING NEEDS, DETERMINE THIS RADAR TO BE NECESSARILY A SPACE STATION MISSION.

PAYLOAD ELEMENT NAME
EMAIP

CODE
BACX0057

TYPE:
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name B.A. TINSLEY
Address MS FO 2.2
BOX 688
RICHARDSON, TX 75080

Telephone 214/690-2837

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1990 Number of Flights Duration of Flight, Days

OBJECTIVE
MONITORING OF SELECTED NIGHTSIDE OPTICAL EMISSIONS TO MEASURE FLUXES OF RING CURRENT PARTICLES PRECIPITATED INTO THE ATMOSPHERE AS ENERGETIC NEUTRALS AND IONS.

DESCRIPTION
AN OPTICAL INSTRUMENT DESIGNED TO DETECT LINE AND BAND EMISSIONS DUE TO PRECIPITATING NEUTRALS/IONS AND OTHER SIMILARLY WEAK EMISSIONS AT INTENSITIES WHICH MAY BE ONLY A FEW PERCENT ABOVE THE ASTRONOMICAL CONTINUUM BACKGROUND (OF ZODIACAL LIGHT, NEBULAE, AND UNRESOLVING FAINT STARTS). OPERATING PRINCIPLE: ANNULAR FOCAL PLANE SPECTRAL SCAN OF INTERFERENCE FILTERS ON A WHEEL, SPECTRAL SCAN TO BE OVER REQUIRED SPECTRAL FEATURE AND BACKGROUND BOTH SIDES OF A FEATURE.

ORIGINAL PAGE IS OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 250 Perigee, km 250 Tolerance + -
Inclination, deg 30.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.10 Field of View (deg) 2.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	200	0.75	
Standby	100	0.75	( ) Continuous
Peak	300	0.10	
Voltage, V		Frequency, Hz	

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 50 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
REQUIREMENT IS FOR SENSITIVITY SO INSTRUMENT SHOULD BE WELL AWAY FROM THRUSTS AND SS GAS, PARTICULATE AND LIGHT SOURCES. BEST ON A TETHERED PLATFORM 500 M OR MORE ABOVE OR BELOW THE STATION WITH 3 AXIS GYRO STABILIZATION. OBSERVATION APPROACH TO MEASURE ATMOSPHERE EMISSION PLUS BACKGROUND ON FORWARD HORIZON IN ORBIT PLANE THEN VIEW ZENITH 1/4 REVOLUTION LATER TO OBTAIN BACKGROUND.

7.1.3 Astrophysics

7.1.3.1 Astrophysics User Data Forms

PAYLOAD ELEMENT NAME
ORBITAL RADIO TELESCOPE

CODE
BACX0002

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
Name FRANK D. DRAKE
Address SPACE SCIENCES BUILDING
CORNELL UNIVERSITY
ITHACA, NY 14853

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 1

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
1) TO PERMIT LONG BASELINE RADIO INTERFEROMETRY IN ASSOCIATION WITH GROUND-BASED OR OTHER ORBITAL RADIO TELESCOPES.
2) TO ACHIEVE A VERY LARGE APERTURE OR FOR MILLIMETER WAVELENGTH OBSERVATIONS ABOVE THE ATMOSPHERE.

DESCRIPTION
A RADIO ANTENNA (RADIO TELESCOPE) OF APPROXIMATELY 30-M DIAMETER WOULD BE PLACED IN ORBIT IN THE PROXIMITY OR ATTACHED TO THE SPACE STATION. IT WOULD HAVE A VERY ACCURATE SURFACE TOLERANCE OF THE ORDER OF 0.1 MM PEAK DEVIATION FROM A PERFECT PARABOLA OR SPHERE. IT WOULD BE USED TO OBSERVE COSMIC RADIO SOURCES SIMULTANEOUS WITH OBSERVATIONS FROM OTHER TELESCOPES ON THE EARTH OR IN SPACE. DATA WOULD BE TELEMETERED TO EARTH. IT WOULD ALSO BE USED AS A STAND-ALONE INSTRUMENT TO OBSERVE SPECTRAL LINES AT MM-WAVELENGTHS FROM GALACTIC GAS AND DUST CLOUDS AND FROM OTHER GALAXIES.

ORIGINAL PAGE IS OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 1.00 Field of View (deg) 10.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating		
Standby		( ) Continuous
Peak	100	
Voltage, V		Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.00 meters Width: 1.00 meters Height: 1.00 meters (Stowed)
Length: 1.00 meters Width: 1.00 meters Height: 1.00 meters (Deployed)
Launch mass, kg: 2000 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See instructions

PAYLOAD ELEMENT NAME
HEAVY ION DETECTOR

CODE
BACX0008

CONTACT
Name DR. ROBERT E. TURNER
Address SCIENCE APPLICATIONS, IN
1010 WOODMAN DRIVE, SUIT
DAYTON, OH 45432

Telephone 513 25 1170

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 0

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO DETECT AND MEASURE ELEMENTS HEAVIER THAN LEAD IN THE COSMIC RAY FLUX.

DESCRIPTION
ELEMENTS HEAVIER THAN LEAD HAVE BEEN DISCOVERED IN THE COSMIC RAY FLUX IN THE PAST 15 YEARS USING HIGH-ALTITUDE BALLOONS AND SOME SATELLITES. WHAT IS NEEDED, HOWEVER, IS A LARGE AREA COSMIC RAY DETECTOR WITH A LONG EXPOSURE TIME AND ONE WHICH CAN BE ANALYZED FROM TIME TO TIME BY INVESTIGATORS AT THE SITE. (CONTACT DR. ROBERT WALKER OF WASHINGTON UNIVERSITY, ST. LOUIS MO).

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	
Standby		( ) Continuous
Peak		
Voltage, V		Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: 1.00	W, m: 1.00	H, m: 1.00	Stowed
L, m: 1.00	W, m: 1.00	H, m: 1.00	Deployed

Launch mass, kg: 75 Return mass, kg: 200
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size 0 Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA (X) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
- ( ) Low
- ( ) Medium
- ( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
- (X) No Restrictions
- ( ) Only with compatible payloads
- ( ) Fly-Alone
- ( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
ASTROMETRIC OPTICAL TELESCOPE

CODE
BACX0009

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
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ITHACA, NY 14853

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO MAKE PHOTOELECTRIC POSITION MEASUREMENTS OF NEARBY STARS WHICH MIGHT POSSESS PLANETARY SYSTEMS - PROGRAM TO CONTINUE OVER A PERIOD OF MORE THAN A DECADE. FROM THE DATA TO DEDUCE THE PRESENCE AND CONFIGURATION OF THE PLANETARY SYSTEMS OF OTHER STARS.

DESCRIPTION
THE INSTRUMENTATION WOULD SIMPLY BE A VERSION OF EQUIPMENT ALREADY DEVELOPED AT THE UNIVERSITY OF PITTSBURGH. THE TELESCOPE ONLY NEEDS TO BE ABOUT 1 M IN APERTURE. THE PROGRAM WOULD BENEFIT FROM THE ESCAPE FROM THE PERTURBING EFFECT OF THE ATMOSPHERE. IN PRINCIPAL, PLANETS OF AS LITTLE AS THE EARTH ARE DETECTABLE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction (X) Inertial ( ) Solar ( ) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 1.00 Field of View (deg) 3.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	100	
Standby		( ) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 1.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 1.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 75 Return mass, kg: 0
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

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CREW REQUIREMENTS
Crew Size

Task Assignments

Skill							
Level							
Hours/Day							

Skills (See Table B)

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
WOULD PROBABLY BEST BE FREE FLIER IN CLOSE PROXIMITY TO SPACE STATION, BUT COULD BE ATTACHED TO SPACE STATION IF SUFFICIENT VIBRATIONAL ISOLATION IS PROVIDED.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
GEOPHYSICAL FLUID FLOW CELL EXPT

CODE
BACX0012

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

CONTACT
Name WILLIAM W. FOWLIS
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SPACE SCIENCE LABORATORY
NASA/GEORGE C MARSHALL S
MARSHALL SPACE FLIGHT CE

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
THE GFFC CAN BE CONSIDERED A MODEL OF STELLAR CONVECTION.

DESCRIPTION
THE GFFC CONSISTS OF TWO CONCENTRIC HEMISPHERES WITH A DIELECTRIC LIQUID BETWEEN THEM. THE INNER HEMISPHERE IS HEATED AND THE OUTER COOLED, AND THE HEMISPHERES ARE ROTATED RIGIDLY ABOUT THE AXIS NORMAL TO THE EQUATORIAL PLANE. A LARGE AC VOLTAGE DIFFERENCE ACROSS THE HEMISPHERES CREATES THE DIELECTRIC BODY FORCE THE PRINCIPAL CRITERION FOR THE OPERATION IS THAT DISTURBING ACCELERATIONS BE SMALL - "QUIET" PERIODS IN ORBIT ARE THUS NECESSARY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	225	
Standby	0	
Peak	545	

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 110 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE OPS CODE

Free Flyer

		OPS CODE
( )	Not Serviced	F
( )	Remote TMS	FT
( )	Remote Manned	FM
( )	Serviced at Station (TMS Retrieved)	FST
( )	Serviced at Station (Self-propelled)	FS

Platform Based

		OPS CODE
( )	Not Serviced	P
( )	Remote TMS	PT
( )	Remote Manned	PM
( )	Serviced at Station (TMS Retrieved)	PST
( )	Serviced at Station (Self-propelled)	PS

Other

		OPS CODE
( )	Space Station Based	SS
( )	Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
GRAVITY WAVES EXPT

CODE
BACX0016

TYPE
(X) Science and Applications (Non-co
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 02

CONTACT
Name DR. JOHN W. FREEMAN
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CODE 601
GREENBELT MD 20771

Telephone 301 344-7251

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
STUDY PHYSICS IN THE MICROGRAVITY ENVIRONMENT

DESCRIPTION
ESTABLISH A LABORATORY FOR THE STUDY OF PHYSICS IN MICROGRAVITY AND SEARCH FOR GRAVITY WAVES FROM OUTSIDE THE SOLAR SYSTEM.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction (X) Inertial ( ) Solar ( ) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	300	
Standby		( ) Continuous
Peak		
Voltage, V		Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
S. S. GAMMA RAY TELESCOPE

CODE
BACX0017

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
Name ROBERT C. HAYMES, CHM
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RICE UNIVERSITY
HOUSTON, TX 77251

Telephone 713 527-4045

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
A. MEASURE VARIABILITY OF (0.1-10) MEV GAMMA RAY ENERGY SPECTRUM FROM SELECTED AND EXTRAGALACTIC SOURCES AND FROM THE COSMIC BACKGROUND.
B. IMAGE SELECTED GALACTIC SOURCES OF GAMMA RADIATION.

DESCRIPTION
A ONE-SQUARE METER SCINTILLATION COUNTER TELESCOPE FABRICATED FROM SODIUM IODIDE AND CESIUM FLUORIDE CRYSTAL THE TELESCOPE ACHIEVES A TYPICAL 3 SENSITIVITY OF 10-7 PHOTONS CM-2 S-1 GIVEN A ONE-MONTH POINTING TIME AT A SOURCE, BY REJECTING INSTRUMENTAL BACKGROUND DUE TO ACTIVATION AND PHOTON LEAKAGE. THE EXPECTED ENERGY RESOLUTION AT GAMMA RAY ENERGY E(MEV) IS 0.15E-1/2 (FWHM) AND THE ANGULAR RESOLUTION EXPECTED FROM THE TELESCOPE´S RANDOMLY CODED APERTURE IS ONE ARC-MINUTE FOR GALACTIC SOURCES, NEGLECTING POINT-STABILITY ERROR

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction (X) Inertial ( ) Solar ( ) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 0.50 Field of View (deg) 30.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	
Standby		(X) Continuous
Peak		
Voltage, V		Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
( ) Active (X) Passive
Temperature, deg C Operational Minimum -40 Maximum 55
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: 1.00 W, m: 1.00 H, m: Deployed
Launch mass, kg: 500 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

ORIGINAL PAGE IS
OF POOR QUALITY

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
COSMIC RAY PHYSICS

CODE
BACX0018

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
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Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MEASURE THE PRIMARY ANTIPROTON FLUX IN COSMIC RAYS AT 100 GEV/C.

DESCRIPTION
WE ARE INTERESTED IN DESIGNING A COMPACT MAGNETIC SPECTROMETER WHICH CAN DETERMINE THE ANTIPROTON FLUX IN PRIMARY COSMIC RAYS. THE CORE OF THE DEVICE WOULD CONSIST OF AN 80 KGAUSS DIPOLE MAGNET WITH 15 X 15 CM APERTURE SURROUNDED BY FOUR PLANES OF CCD´S TO DETERMINE CHARGED PARTICLE TRAJECTORIES TO A PRECISION OF A FEW MICRONS.

ORIGINAL PAGE IS
OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	
Standby		(X) Continuous
Peak		
Voltage, V		Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 75 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size
Task Assignments
Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
DEVICE MUST BE SUPPORTED WITH LIQUID HE4 FOR THE SUPERCONDUCTING MAGNET.

Boeing-Specific Input Data

MISSION TYPE OPS CODE

Free Flyer
- ( ) Not Serviced F
- ( ) Remote TMS FT
- ( ) Remote Manned FM
- ( ) Serviced at Station (TMS Retrieved) FST
- ( ) Serviced at Station (Self-propelled) FS

Platform Based
- ( ) Not Serviced P
- ( ) Remote TMS PT
- ( ) Remote Manned PM
- ( ) Serviced at Station (TMS Retrieved) PST
- ( ) Serviced at Station (Self-propelled) PS

Other
- ( ) Space Station Based SS
- ( ) Sortie SOR

CONSTRUCTION/SERVICING COMPLEXITY
- ( ) Low
- ( ) Medium
- ( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
- (X) No Restrictions
- ( ) Only with compatible payloads
- ( ) Fly-Alone
- ( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
IMAGING GAMMA-RAY TELESCOPE FACI

CODE
BACX0032

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
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CALIFORNIA INSTITUTE OF
PASADENA, CA 91125

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 3

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
SPECTROSCOPY AND IMAGING OF SELECTED ASTROPHYSICAL OBJECTS IN TE ENERGY RANGE 30 KEV TO 10 MEV WITH AN ANGULAR RESOLUTION OF 1 ARC MIN OR BETTER AND AN ENERGY RESOLUTION OF 1.5 TO 4 KEV.

DESCRIPTION
THE IMAGING GAMM-RAY TELESCOPE WOULD CONSIST OF A DETECTOR ARRAY, ACTIVE SHIELD, AND CODED APERTURE MASK. THE PRIMARY DETECTOR SYSTEM WOULD CONSIST OF 19 HIGH-PURITY GE DETECTORS MOUNTED IN A VACUUM CRYSTAT. AN ALTERNATE DETECTOR MODULE WOULD CONSIST OF A LARGE AREA NAI ANGER CAMERA DETECTOR. THE DETECTOR ARRAY WOULD BE SURROUNDED BY AN ACTIVE 5" NAI SHEIDL WITH AN OPENING APERTURE OF 30 DEG. A L-M DIAMETER CODED APERTURE MASK FABRICATED FROM LEAD WOULD BE SITUATED AT A DISTANCE OF 40 M FROM THE DETECTOR PLANE. THE CELL SIZE OF MASK ELEMENTS WOULD BE 1-6 CM DEPENDING ON THE TYPE OF DETECTOR USED AND THE MASK WOULD BE 3 CM THICK.

ORBIT CHARACTERISTICS
Geosynchronous
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 10.00 Field of View (deg) 2.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	250	.50
Standby		
Peak	250	
Voltage, V		Frequency, Hz

(X) Continuous

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	20	Maximum	35
	Non-operational Minimum		Maximum	
Heat Rejection, w	Operational Minimum		Maximum	
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: 1.5	W, m: 1.5	H, m: 1.5	Stowed
L, m: 1.5	W, m: 1.5	H, m: 1.5	Deployed

Launch mass, kg: 2000 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days 0 Consumables, kg 0
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
THE FOLLOWING ARE ITEMS THAT POTENTIALLY INVOLVE INTERACTIONS WITH STATION CREW+
1) DEPLOYMENT/STORAGE OF EXTENDABLE BOOM FOR CODED APERTURE MASK.
2) LIQUID NITROGEN REPLACEMENT FOR GE DETECTOR CRYSTAT.
30 MAINTENANCE OF ELECTRONICS & DETECTORS.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
COSMIC RAY COMP/ENERGY

CODE
BACX0056

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational (X) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1983 Number of Flights 1 Duration of Flight, Days

OBJECTIVE
ELEMENTAL COMPOSITION AND ENERGY SPECTRA OF COSMIC RAY NUCLEI BETWEEN 50 GEV/NUCLEON AND SEVERAL TEV PER NUCLEON

DESCRIPTION
THIS EXPERIMENT MAKES FULL USE OF SPACELAB CAPABILITIES BY EXPOSING AN INSTRUMENT OF LARGE VOLUME AND CONSIDERABLE MASS FOR AN EXTENDED PERIOD OF TIME UNINFLUENCED BY ATMOSPHERE AND EXPLORES THE COSMIC RAY COMPOSITION TO ENERGIES MORE THAN 10 TIMES THOSE PRESENTLY REACHED. IT WILL APPROACH THE IMPORTANT REGION OF ULTRA-HIGH ENERGIES WHERE ONLY INDIRECT MEASUREMENTS ARE PRESENTLY MADE. THE EXPERIMENT WILL USE (A) GAS CERENKOV COUNTERS AND (B) TRANSITION RADIATION DETECTORS, BOTH WHICH REQUIRE LOW DENSITY AND LIGHT WEIGHT, THUS PERMITTING LARGE INSTRUMENT CONSTRUCTION.

ORBIT CHARACTERISTICS
Geosynchronous Orbit (X) Yes ( ) No
Apogee, km 35786 Perigee, km 35786 Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg) 70.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	369	*****
Standby	100	
Peak	369	
Voltage, V	28	Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

( ) Active ( ) Passive

Temperature, deg C	Operational Minimum	10	Maximum	60
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	369	Maximum	369
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: 3.70 meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 2200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

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CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	days	Consumables	kg
	Returnables	kg	Man hours required	
Configuration Changes:	Interval	days	Man-Hours Required	
	Deliverables	kg	Returnables	kg

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT NAME
SOLAR MONITOR

CODE
BACX0005

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 1

CONTACT
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Telephone 513 258-1170

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 0

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO MONITOR THE SOLAR SPECTRUM IN THE VISIBLE AND INFRARED OVER A LONG TIME PERIOD (YEARS)

DESCRIPTION
ALTHOUGH PRESENT SATELLITE SENSORS MEASURE THE SOLAR "CONSTANT", I.E. THE SOLAR OUTPUT INTEGRATED OVER ALL WAVELENGTHS, NO SENSOR HAS EVER MEASURED THE SOLAR SPECTRUM OUTSIDE THE ATMOSPHERE ON A ROUTINE BASIS. NOT ONLY WOULD THIS SENSOR PROVIDE DATA FOR SOLAR PHYSICS RESEARCH BUT IT WOULD BE OF ENORMOUS INTEREST TO CLIMATOLOGISTS AND USERS OF VISIBLE AND NEAR INFRARED MULTISPECTRAL DATA. NO ONE KNOWS HOW MUCH THE SOLAR SPECTRUM FLUCTUATES OR WHAT ITS FREQUENCY IS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial (X) Solar ( ) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 0.50 Field of View (deg) 2.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	300	
Standby		( ) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 1.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 1.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 75 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size 0 Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

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Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

7.1.4 Earth Observations

7.1.4.1 Earth Resource Bibliography

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Courtesy of ERIM

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______________, Multispectral Scanner Data Applications Evaluations, Volume II - Sensor System Study, Final Report, Report No. 102800-40-F (NASA/JSC 09421), Ann Arbor, Environmental Research Institute of Michigan, Contract NAS9-13386, December 1974.

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University of Michigan, Applications of Earth-Observation Spacecraft: Benefits and Manned Earth Orbital Experiments, Volume I, Ann Arbor, Infrared and Optical Sensor Laboratory, Institute of Science and Technology, University of Michigan, prepared for Space Guidance Center, Federal Systems Division, International Business Machines, Corp., under NASA Prime Contract NASW-1084, April 1965.

______________, Applications of Earth-Observation Spacecraft: Benefits and Manned Earth Orbital Experiments, Volume II, Ann Arbor, Infrared and Optical Sensor Laboratory, Institute of Science and Technology, University of Michigan, prepared for Space Guidance Center, Federal Systems Division, International Business Machines, Corp., under NASA Prime Contract NASW-1084, April 1965.

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7.1.4.2 Earth Observations Researchers

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7.1.4.3 Earth Observations User Data Forms

PAYLOAD ELEMENT NAME
MARGINAL ICE ZONE OBSERVATIONS

CODE
BACX0006

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
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13400 B NORTHRUP WAY #36
BELLEVUE, WA 98125

Telephone 206/747-7152

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 2

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO OBTAIN VISIBLE, IMFRARED, MICROWAVE (ACTIVE AND PASSIVE) AND OTHER OBSERVATIONS OF ICE DISTRIBUTION AND CHARACTERISTICS IN THE NORTHERN HEMISPHERE MARGINAL ICE ZONES. THIS INFORMATION WILL SUPPLEMENT GROUND TRUTH DATA TO BE GATHERED FROM SURFACE VESSELS, AIRCRAFT AND FROM ICE-BASED PLATFORMS.

DESCRIPTION
INSTRUMENTATION OF THE EARTH OBSERVATION FACILITY WILL BE USED TO PROVIDE HIGHER RESOLUTION OF OBSERVATIONS OF THE MARGINAL ICE ZONES THAN HAS BEEN POSSIBLE WITH SATELLITE-MOUNTED SENSORS, WITH COVERAGE OVER A WIDER

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	.5
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: 1.00 meters Width: 1.00 meters Height: 1.00 meters (Stowed)
Length: 1.00 meters Width: 1.00 meters Height: 1.00 meters (Deployed)
Launch mass, kg: 75 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

PAYLOAD ELEMENT NAME
LIDAR-CIDS

CODE
BACX0007

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 0

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
1) MONITOR SOVIET BIOLOGICAL AGENT PRODUCTION FACILITIES
2) MONITOR CROP HEALTH
3) MONITOR AEROSOL CLOUDS.

DESCRIPTION
CIRCULAR INTENSITY DIFFERENTIAL SCATTERING (CIDS) IS THE DIFFERENTIAL SCATTERING OF LEFT AND RIGHT CIRCULARLY POLARIZED LIGHT. IT IS EXTREMELY SENSITIVE TO THE DIFFERENCES IN LONG RANGE ORDER IN THE GENETIC MATERIAL IN MICROORGANISMS. BACKSCATTER CIDS MEASUREMENTS (IN THE LAB) HAVE ENABLED US TO DISCRIMINATE AMONG A VARIETY OF MICROORGANISMS.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg . Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s .

POINTING/ORIENTATION
View Direction (/) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	1.00
Standby		
Peak		
Voltage, V	24	Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None ( ) Realtime (X) Offline ( ) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

(X) On-Board Data Processing Required

Description:

Data Types: (X) Analog (X) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C Operational Minimum Maximum

Non-operational Minimum Maximum

Heat Rejection, w Operational Minimum Maximum

Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote

Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: 1.00 W, m: 1.00 H, m: 1.00 Stowed

L, m: 1.00 W, m: 1.00 H, m: 1.00 Deployed

Launch mass, kg: 50 Return mass, kg: 0

Consumable Types

Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg

Returnables, kg Man hours

Configuration Changes: Interval, day Man/Hours Required

Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY

( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions

(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
OCEAN RESEARCH/REMOTE SENSING OF

CODE
BACX0019

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
1) OBSERVATIONS OF LARGE-SCALE FEATURES AND COMPARE OBSERVATIONS WITH REAL TIME INFORMATION FROM REMOTE SENSORS ON BOARD
2) MONITOR IN REAL TIME THE SIGNATURES OF VARIOUS CLASSES OF SEA ICE WHILE PHYSICALLY VARYING SENSOR PARAMETERS.

DESCRIPTION
OBSERVATIONS OF LARGE-SCALE FEATURES ON A REAL-TIME BASIS CAN ENABLE AT LEAST VERIFICATION OF EXISTENCE AND A FIRST ORDER APPRECIATON OF TIME AND SPACE SCALES. OPTIMUM SITUATION TO COMPARE OBSERVATIONS OF FEATURES WITH REAL TIME NFORMATION FROM SELECTED REMOTE SENSORS, ALLOWING MAXIMUM INTERACTION BETWEEN THE SCIENTIST ON THE SPACE STATION AND GROUND TRUTH PARTIES ON THE SEA SURFACE WHO COULD BE DIRECTED TO SPECIFIC LOCATIONS REMOTE SENSING ASSUMES AVAILABILITY OF BOTH ACTIVE AND PASSIVE SENSORS AND REAL TIME PROCESSING OF DATA ON BOARD, WITH ABILITY TO DIRECT GROUND TRUTH PARTIES TO SPECIFIC LOCATIONS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg 90 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	.50
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 75 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size
Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
MULTISPECTRAL SENSOR

CODE
BACX0021

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO PROVIDE SAME BASIC COVERAGE OF EARTH'S SURFACE AS LANDSAT WITH SIMULTANEOUS ATMOSPHERIC INFORMATION.

DESCRIPTION
A SIMILAR HIGH RESOLUTION MULTISPECTRAL SCANNER AS LANDSAT OR THE FRENCH SPOT BUT WHICH LOOKS AT THE EARTH'S SURFACE AT SEVERAL DIRECTIONS (MULTIASPECT) AT ONCE. THIS WOULD ALLOW INVESTIGATORS TO EXAMINE AN IMPORTANT PART OF SURFACE REFLECTANCE, I.E. GONIOMETRIC OR BIDIRECTIONAL REFLECTANCE PROPERTIES. ONE COULD OBSERVE ANGULAR EFFECTS AND SIMULTANEOUSLY DETECT RADIATION IN THE STRONG WATER VAPOR ABSORPTION BANDS. THUS, WE COULD OBTAIN GREATLY IMPROVED SPECTRAL AND ANGULAR SIGNATURES WITH ATMOSPHERIC CORRECTION INCLUDED.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	600	1	
Standby			(X) Continuous
Peak			
Voltage, V		Frequency, Hz	

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal (X) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: 1	W, m: 2	H, m: 1	Stowed
L, m: 1	W, m: 2	H, m: 1	Deployed

Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+ max: E+

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CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
THIS SENSOR WILL BE MULTISPECTRAL (AS LEAST SEVEN WAVELENGTH BANDS) AND MULTIASPECT. IT WILL LOOK AT FIVE SCAN LINES SIMULTANEOUSLY.

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
OCEAN REMOTE SENSING

CODE
BACX0022

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name ROBERT L. BERNSTEIN A-021
Address CALIFORNIA SPACE INSTITU
SCRIPPS INSTITUTION OF O
LA JOLLA, CA 92093

Telephone (619) 452-4233

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 4

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
GENERAL REMOTE SENSING OF NUMEROUS OCEAN PARAMETERS, EMPLOYING A SUITE OF INSTRUMENTS OPERATING ACTIVELY OR PASSIVELY IN THE VISIBLE, INFRARED, AND MICROWAVE PORTIONS OF THE SPECTRUM.

C-3

DESCRIPTION
SEASAT, NUMBUS AND TIROS-N SPACECRAFT SENSORS HAVE ESTABLISHED THAT USEFUL MEASUREMENT OF MANY OCEAN PARAMETERS (E.G. SEA SURFACE TEMPERATURE, WIND, CHLOROPHYLL, CURRENT) CAN BE MADE REMOTELY. BEST RESULTS ARE OBTAINED WHEN ALL OR MOST OF THE INSTRUMENTS SHARE THE SAME PLATFORM. THE NEXT GENERATION OF INSTRUMENTATION WILL REQUIRE LARGE (4 M) ANTENNAS FOR MICROWAVE RADIOMETRY, SUBSTANTIAL POWER (TO DRIVE ACTIVE RADARS, FOR EXAMPLE) SIGNIFICANT DATA PREPROCESSING, AND DATA REDUCTION OPERATIONS PRIOR TO TRANSMISSION TO THE EARTH, & FLEXIBILITY TO RECONFIGURE & REPAIR SENSORS. IN ADDITION, THE INSTRUMENTS MUST CONTINUALLY PRODUCE DATA & MAINTAIN CALIBRATION FOR PERIODS OF A YEAR OR MORE.

ORIGINAL PAGE IS OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg 100.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m 5
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec 0.05 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	
Standby		(X) Continuous
Peak		
Voltage, V		Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 1 W, m: 1 H, m: 1 Stowed
L, m: 1 W, m: 1 H, m: 1 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size Task Assignments
Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
OCEAN RESEARCH INSTRUMENTATION

CODE
BACX0023

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name DUNCAN ROSS
Address ATLANTIC OCEANOG. AND ME
SEA-AIR INTERACTION LABO
4301 RICKENBACKER CAUSEW
MIAMI, FL 33149

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 3

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
INSTRUMENTS TO SERVE A VARIETY OF OCEAN/ICE/LAND USERS WHOSE HIGH RESOLUTION REQUIREMENTS COMPLICATES THEIR USE ON OTHER SATELLITES.

DESCRIPTION
1) MOST OCEANOGRAPHIC REQUIREMENTS ARE BETTER MET VIA HIGHLY SPECIALIZED OPERATIONAL SATELLITES.
2) A GENERAL SPACE STATION SHOULD BE CAPABLE OF EXTREMELY HIGH RESOLUTION MULTI-BAND PHOTOGRAPHY AND SYNTHETIC APERTURE RADAR IMAGING. DEGRADED OPTICAL AND RADAR IMAGING WOULD BE USEFUL TO THE OCEANOGRAPHIC COMMUNITY. 3) A HIGH RESOLUTION VISIBLE REGION COLOR SCANNER WOULD ALSO BE USEFUL TO OCEANOGRAPHIC STUDIES.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg 80.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	700	
Standby		(X) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 1 W, m: 2 H, m: 1 Stowed
L, m: 1 W, m: 2 H, m: 1 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size

Skills (See Table B)

Task Assignments

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH OBSERVATION FACILITY

CODE
BACX0042

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name BOB BARKER
Address ST. REGIS PAPER CO
435 CLARK ROAD
JACKSONVILLE, FL

Telephone 904/764-0545

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
1) MONITOR AND ASSESS EPISODAL EVENTS (FOREST FIRES, SEVERE STORMS, SEARCH AND RESCUE, EARTHQUAKE, FLOOD, ETC.)
2) MANAGEMENT OF LARGE AREAS OF FORESTRY/AGRICULTURE

DESCRIPTION
A POINTABLE MULTISPECTRL IMAGER MANNED BY A SPECIALIST IN ORBIT WILL LOCATE AND MEASURE EVENTS SUCH AS FLOOD, FIRES, AND SEVERE STORMS AND WILL DETERMINE THE EXTENT OF SUCH THREATS AND LOSSES. IT WOULD ALSO BE OF USE IN MEASUREMENT OF CHANGE IN FOILAGE, OF LEVEL FORM CHANGES, OF SITES FOR TREE GROWING AND IN ALLOCATION OF WATER RESOURCES.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 3.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 3.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size

Task Assignments

Skill							
Level							
Hours/Day							

Skills (See Table B)

EVA ( ) Yes (X) No Reason

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

ORIGINAL PAGE IS OF POOR QUALITY

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
EARTH OBSERVATION FACILITY

CODE
BACX0043

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name R. HILL
Address JOHNSON SPACE CENTER

JACKSONVILLE, FL

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 10

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
DEVELOP IMPROVED DETECTORS AND TECHNIQUES BY MODIFYING THE INSTRUMENT IN SITU (IN ORBIT) AS USE MAY DICTATE.

DESCRIPTION
DEPLOY A MODULAR AND FLEXIBLE SENSOR: IMPROVED SPATIAL & SPECTRAL RESOLUTION, POINTABLE FOR TRACKING AND OPTIMAL OBSERVATION ANGLE; POLARIZATION; SELECTABLE SPECTRAL BANDS.

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OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg . Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s .

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 3.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 3.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size

Skills (See Table B)

Task Assignments

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE   OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH OBSERVATIONS FACILITY

CODE
BACX0044

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

CONTACT
Name H.G. REICHLE, JR
Address LRC

JACKSONVILLE, FL

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 5

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MEASURE ATMOSPHERIC TRACE GASES, THEIR PRESENCE, MOVEMENTS, DENSITY AND POSSIBLE CHEMICAL TRANSITIONS.

DESCRIPTION
THIS DETECTOR WILL BE TAILORED TO MEASURE ATMOSPHERIC TRACE GASES BY RECORDING CHARACTERISTIC ABSORPTION AND EMISSION SPECTRAL LINES. IT MAY BE USED IN CONJUNCTION WITH OTHER INSTRUMENTS THAT SEEK TO ACTIVELY EXCITE ATMOSPHERIC MOLECULES WITH LASERS AND MEASURE FLORESCENCE AND RAMAN EMISSIONS. THE POWER SHOULD BE FLEXIBLE IN FREQUENCY SELECTION AND BANDWIDTH.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
(X) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	200	.5
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 2.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 2.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 150 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

ORIGINAL PAGE IS
OF POOR QUALITY

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH OBSERVATION FACILITY

CODE
BACX0045

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 2

CONTACT
Name R.V. HESS
Address LRC

JACKSONVILLE, FL

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 5

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MEASURE ATMOSPHERIC TRACE GAS CONCENTRATIONS AND WIND VELOCITY AND TRANSPORT PARAMETERS.

DESCRIPTION
CO2 LIDAR, HIGH PULSE ENERGY AND REPETITION RATES; WIDE TUNING RANGE WITH HIGH FREQUENCY STABILITY.
THE MEASUREMENT MAY CHOOSE TO COORDINATE WITH OTHER EXPERIMENTERS SUGGESTING POSS[illegible] [illegible]EODYMIUM LASERS TO PROBE ATMOSPHERIC CONSTITUENTS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	
Standby		( ) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 2.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 2.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 150 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size

Task Assignments

Skill						
Level						
Hours/Day						

Skills (See Table B)

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

ORIGINAL PAGE IS OF POOR QUALITY

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY

( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions

(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH OBSERVATIONS FACILITY

CODE
BACX0046

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name LD STATON
Address LRC

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 5

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
ALL WEATHER MEASUREMENT OF CLOUD THICKNESS AND HEIGHT, RAIN RATES, AND WINDS FOR APPLICATION TO METEOROLOGY, CROP PREDICTIONS, FLOOD PREDICTIONS.

DESCRIPTION
DOPPLER PUSHBROOM RADAR USING LARGE (750M) PHASED ARRAY ANTENNA, ASSEMBLED IN ORBIT MODULARLY.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg >60. Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	3000	1.00
Standby	300	
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 3.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 3.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 500 Return mass, kg: 0
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg 0
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

ORIGINAL PAGE IS OF POOR QUALITY

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH OBSERVATIONS FACILITY

CODE
BACX0048

TYPE
(X) SCIENCE AND APPLICATIONS (NON-COMM.)
( ) COMMERCIAL
( ) TECHNOLOGY DEVELOPMENT
( ) OPERATIONS
( ) OTHER
( ) NATIONAL SECURITY
TYPE NUMBER (SEE TABLE A) 19

CONTACT
NAME R.F. HARRINGTON
ADDRESS LANGLEY RESERCH CENTER

TELEPHONE

IMPORTANCE OF THE SPACE STATION TO THIS ELEMENT
1 = LOW VALUE, BUT COULD USE
10 = VITAL
SCALE = 5

STATUS
( ) OPERATIONAL ( ) APPROVED ( ) PLANNED ( ) CANDIDATE (X) OPPORTUNITY

DESIRED FIRST FLIGHT, YEAR: NUMBER OF FLIGHTS DURATION OF FLIGHT, DAYS

OBJECTIVE
USE PASSIVE MICROWAVE DETECTION TO DERIVE SUCH PARAMETERS AS SOIL MOISTURE, SEA SURFACE TEMPERATURES, OCEAN SURFACE WIND SPEED, RAIN RATE, SEA ICE CLASSIFICATION, ATMOSPHERIC DATA, ETC.

DESCRIPTION
MULTIFREQUENCY, MULTIPLE BEAM IMAGING MICROWAVE RADIOMETER.

ORBIT CHARACTERISTICS
GEOSYNCHRONOUS ORBIT ( ) YES (X) NO
APOGEE, KM LEO PERIGEE, KM LEO TOLERANCE + -
INCLINATION, DEG >60 TOLERANCE + -
NODAL ANGLE, DEG EPHEMERIS ACCURACY, M
ESCAPE DV REQUIRED, M/S

POINTING/ORIENTATION
VIEW DIRECTION ( ) INERTIAL ( ) SOLAR (X) EARTH ( ) ANY
TRUTH SITES (IF KNOWN)
POINTING ACCURACY, ARC-SEC FIELD OF VIEW (DEG)
POINTING STABILITY (JITTER), ARC-SEC/SEC
SPECIAL RESTRICTIONS (AVOIDANCE)

POWER
( ) AC ( ) DC

	POWER, W	DURATION, HRS/DAY
OPERATING	3000	.5
STANDBY		
PEAK		

( ) CONTINUOUS

VOLTAGE, V FREQUENCY, HZ

DATA/COMMUNICATIONS

MONITO[illegible] REQUIREMENTS:
( ) NO[illegible] ( ) REALTIME ( ) OFFLINE ( ) OTHER:
( ) ENCRIPTION/DECRIPTION REQUIRED
( ) UPLINK REQUIRED: COMMAND RATE (KBS): FREQUENCY (MHZ):
(X) ON-BOARD DATA PROCESSING REQUIRED
DESCRIPTION:
DATA TYPES: (X) ANALOG (X) DIGITAL HOURS/DAY
FILM (AMOUNT): VOICE (HOURS/DAY):
LIVE TV (HOURS/DAY): OTHER:
ON-BOARD STORAGE (MBIT):
DATA DUMP FREQUENCY (PER ORBIT) DOWNLINK COMMAND RATE:
RECORDING RATE (KBPS) DOWNLINK FREQUENCY (MHZ):

THERMAL
(X) ACTIVE ( ) PASSIVE
TEMPERATURE, DEG C OPERATIONAL MINIMUM MAXIMUM
NON-OPERATIONAL MINIMUM MAXIMUM
HEAT REJECTION, W OPERATIONAL MINIMUM MAXIMUM
NON-OPERATIONAL MINIMUM MAXIMUM

EQUIPMENT PHYSICAL CHARACTERISTICS
LOCATION ( ) INTERNAL ( ) EXTERNAL ( ) REMOTE
EQUIPMENT ID/FUNCTION (X) PRESSURIZED ( ) UNPRESSURIZED

L, M:	3.00	W, M:	1.00	H, M:	1.00	STOWED
L, M:	3.00	W, M:	1.00	H, M:	1.00	DEPLOYED

LAUNCH MASS, KG: 500 RETURN MASS, KG:
CONSUMABLE TYPES
ACCELERATION SENSITIVITY, (G) MIN: E+00 MAX: E+00

CREW REQUIREMENTS
CREW SIZE TASK ASSIGNMENTS

SKILLS (SEE TABLE B)

SKILL						
LEVEL						
HOURS/DAY						

EVA ( ) YES (X) NO REASON HOURS/EVA

SERVICING/MAINTENANCE
SERVICE: INTERVAL, DAYS CONSUMABLES, KG
RETURNABLES, KG MAN HOURS
CONFIGURATION CHANGES: INTERVAL, DAY MAN/HOURS REQUIRED
DELIVERABLES, KG RETURNABLES, KG

SPECIAL CONSIDERATIONS/SEE INSTRUCTIONS

BOEING-SPECIFIC INPUT DATA

MISSION TYPE	OPS CODE
FREE FLYER	
( ) NOT SERVICED	F
( ) REMOTE TMS	FT
( ) REMOTE MANNED	FM
( ) SERVICED AT STATION (TMS RETRIEVED)	FST
( ) SERVICED AT STATION (SELF-PROPELLED)	FS
PLATFORM BASED	
( ) NOT SERVICED	P
( ) REMOTE TMS	PT
( ) REMOTE MANNED	PM
( ) SERVICED AT STATION (TMS RETRIEVED)	PST
( ) SERVICED AT STATION (SELF-PROPELLED)	PS
OTHER	
( ) SPACE STATION BASED	SS
( ) SORTIE	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) LOW
( ) MEDIUM
( ) HIGH

OPERATIONS TIMES	
OTV UP/DOWN	DAYS
OTV OR TMS ON ORBIT	DAYS
MISSION USE	DAYS/YEAR
IVA SERVICE	MAN-DAYS/YEAR
EVA SERVICE	MAN-DAYS/YEAR
EXPERIMENT OPS	MAN-DAYS/YEAR
SERVICE FREQUENCY	TIMES/YEAR

DELTA VELOCITIES	
UP	0.00
DOWN	0.00
AERO RETURN	0.00

SUPPORT EQUIPMENT

LENGTH:	0.00 METERS	WIDTH:	0.00 METERS	HEIGHT:	0.00 METERS	(STOWED)
LENGTH:	0.00 METERS	WIDTH:	0.00 METERS	HEIGHT:	0.00 METERS	(DEPLOYED)

MASS: 0 KG

MANIFEST RESTRICTIONS
(X) NO RESTRICTIONS
( ) ONLY WITH COMPATIBLE PAYLOADS
( ) FLY-ALONE
( ) MUST HAVE DOCKING MODULE

LENGTH OF BEAM FAB	0.00
NUMBER OF APPENDAGES	0
NUMBER OF MODULES REQUIRED TO ASSEMBLE THE PAYLOAD	0

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PAYLOAD ELEMENT NAME
EARTH OBSERVATIONS FACILITY

CODE
BACX0049

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name W.E. HOWELL
Address LANGLEY RESEARCH CENTER

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 10

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
DEVELOP SENSORS WITH WIDE VARIETY OF ATTRIBUTES CAPABLE OF OPTIMALLY DETECTING EARTH PHENOMENAS. MODULARITY AND ADAPTABILITY IN ORBIT WILL PROVIDE THE FLEXIBILITY FOR IMPROVED DATA COLLECTION.

DESCRIPTION
POINTABLE IMAGING SPECTROMETER WITH OPTIONS TO FIX POINTING DIRECTION. INTEGRATE IMAGE, CHANGE IFOV, CHANGE BANDWIDTHS AND RECORD POLARIZATION.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg . Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s .

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	700	.50
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 3.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 3.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size
Task Assignments

Skills (See Table B)

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

ORIGINAL PAGE IS OF POOR QUALITY

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length:	0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)
Mass:	0 kg			

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH OBSERVATIONS FACILITY

CODE
BACX0051

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT

Name ROBERT KELLY
Address ARIZONA DEPT. OF WATER R
99 E. VIRGINIA
PHOENIX, AZ 85004

Telephone 602/255-1566

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
PROVIDE REAL-TIME OBSERVATION OF AGRICULTURAL LEVELS FOR FARM MANAGEMENT AND PUBLIC OR PRIVATE WATER MANAGEMENT. CURRENT OVERDRAFT OF GROUND-WATER SUPPLIES, DECLINING WATER QUALITY, AND GROUND SUBSIDENCE CAN BE CORRECTED THROUGH MONITORING AND MANAGEMENT OF THE FARM SITE BY OR IN COOPERATION WITH GOVERNMENTAL ENVIRONMENTAL MANAGEMENT OFFICES.

DESCRIPTION
HIGH RESOLUTION MULTISPECTRAL IMAGING SYSTEM OF THE EARTH OBSERVATION FACILITY, VIZ, POINTABLE, IMAGING SPECTROMETER AND MULTISPECTRAL SCANNER.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg >60 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	700	.50
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 3.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 3.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 200 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
EARTH RESOURCES FACILITY

CODE
BACX0052

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name CARL P. SCHUMACHER
Address MONSANTO AGRICULTURAL PR
MARKET RESEARCH DIRECTOR
800 N LINDBERGH, C3NK
ST. LOUIS, MO 63167

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 1

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
PROVIDE MULTISPECTRAL IMAGERY SIMILAR TO OR AN ENHANCED VERSION OF THE THEMATIC MAPPER NOW ON LANDSAT D

DESCRIPTION
A MULTISPECTRAL SCANNER AS PROVIDED ON THE LANDSAT AND SKYLAB SATELLITES WILL CONTINUE TO SERVE THE NEEDS OF USERS WHO HAVE INTEGRATED SATELLITE DATA INTO THEIR DATA SYSTEMS OVER THE PAST DECADE; ROUTINE COVERAGE OF AGRICULTURE AREAS. THE PROPOSAL IMAGING SPECTROMETER WILL ALSO PROVIDE ENHANCED SPECTROGRAPHIC DATA, BUT PROBABLY NOT ROUTINELY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg >60 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
(X) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	500	2.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 2.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 2.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 100 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

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CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE OPS CODE

Free Flyer

( )	Not Serviced	F
( )	Remote TMS	FT
( )	Remote Manned	FM
( )	Serviced at Station (TMS Retrieved)	FST
( )	Serviced at Station (Self-propelled)	FS

Platform Based

( )	Not Serviced	P
( )	Remote TMS	PT
( )	Remote Manned	PM
( )	Serviced at Station (TMS Retrieved)	PST
( )	Serviced at Station (Self-propelled)	PS

Other

( )	Space Station Based	SS
( )	Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
EARTH OBSERVATION FACILITY

CODE
BACX0053

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 19

CONTACT
Name JAMES BRUMFIELD
Address DEPT OF BIOSCIENCE AND P
MARSHALL UNIVERSITY
HUNTINGTON, WEST VIRGINI

Telephone 304/696-2408

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MONITOR THE EARTH (US) WITH A POINTABLE IMAGING SPECTROMETER, IDEALLY A CONSTANT "EARTH WATCH".

DESCRIPTION
A POINTABLE IMAGING SPECTROMETER OPERATED BY A MAN IN ORBIT WILL LOCATE AND MEASURE AREAS OF INTEREST. THE INSTRUMENT WILL BE FLEXIBLE IN THAT IT WILL ADAPT TO A VARIETY OF REQUIREMENTS BY INTERCHANGING MODULAR COMPONENTS TO ACHIEVE IDEAL SPECTRAL CHARACTERISTICS, INSTANTANEOUS FIELD OF VIEW, AND POLARIZATION.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km LEO Tolerance + -
Inclination, deg >4
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	700	1.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None ( ) Realtime ( ) Offline ( ) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

(X) On-Board Data Processing Required

Description:

Data Types: (X) Analog (X) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C Operational Minimum Maximum

Non-operational Minimum Maximum

Heat Rejection, w Operational Minimum Maximum

Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote

Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m:	3.00	W, m:	1.00	H, m:	1.00	Stowed
L, m:	3.00	W, m:	1.00	H, m:	1.00	Deployed

Launch mass, kg: 200 Return mass, kg:

Consumable Types

Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg

Returnables, kg Man hours

Configuration Changes: Interval, day Man/Hours Required

Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
SHORT LIVED PHENOMENA

CODE
BACX0058

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name A.N. SELLMAN
Address ERIM
PO BOX 8618
ANN ARBOR MI 48107

Telephone 313/994-1200

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
OBSERVE AND ANALYZE SHORT LIVED EVENTS WHEN COVERED BY SPACE STATION ORBIT.

DESCRIPTION
AS OBSERVATION OPPORTUNITIES OCCUR, OBTAIN COVERAGE OF VOLCANIC ERUPTIONS AND THEIR EFFECTS ON THE ATMOSPHERE, EARTHQUAKES, OIL SPILLS, WATER POLLUTION, AIR POLLUTION, HURRICANES, STORM SURGES, FOREST FIRES, FLOODS, ETC. PROVIDE RESULTING DATA TO COGNIZANT SCIENTISTS AND/OR MISSION AGENCIES FOR ANALYSIS AND MITIGATION.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km Tolerance + -
Inclination, deg 90.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC
Power, W Duration, Hrs/Day

Operating
Standby ( ) Continuous
Peak
Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None (X) Realtime ( ) Offline ( ) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

( ) On-Board Data Processing Required

Description:

Data Types: ( ) Analog ( ) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL

( ) Active ( ) Passive

Temperature, deg C Operational Minimum Maximum

Non-operational Minimum Maximum

Heat Rejection, W Operational Minimum Maximum

Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote

Equipment ID/Function ( ) Pressurized ( ) Unpressurized

Length: meters Width: meters Height: meters (Stowed)

Length: meters Width: meters Height: meters (Deployed)

Launch mass, kg: Return mass, kg:

Consumable Types

Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Consumables kg

Returnables kg Man hours required

Configuration Changes: Interval days Man-Hours Required

Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions

CONSISTS OF A VARIETY OF OBSERVATIONS HAVING DIVERSE REQUIREMENTS. OBSERVATIONS AT HIGH INCLINATIONS WOULD USE FREE FLYERS. GROUND AREAS ARE HIGHLY VARIABLE FROM A FEW SQUARE MILES (E.G. FOREST FIRE) TO THOUSANDS OF SQUARE MILES (E.G. HURRICANE). HURRICANES AND FOREST FIRES REQUIRE REAL TIME RESPONSE.

PAYLOAD ELEMENT NAME
EARTH VIEWING PARAMETER ANALYSI

CODE
BACX0059

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name A.N. SELLMAN
Address ERIM
PO BOX 8618
ANN ARBOR, MI 48107

Telephone 313/994-1200

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO CHARACTERIZE THE INFORMATION CONTENT OF REMOTELY SENSED FEATURES UNDER VARYING PARAMETRIC CONDITIONS INCLUDING VIEW ANGLE, SUN ANGLE, TIME OF DAY, POLARIZATION AND DAY/NIGHT VIEWING.

DESCRIPTION
LIMITED INFORMATION EXISTS RELATED TO MULTI-WAVE, MULTI-DIRECTIONAL, MULTI-POLARIZATIONAL CHARACTERISTICS OF A NUMBER OF COVER TYPES. THIS EXTENSIVE EXPERIMENT IS DESIGNED TO EXPLORE THOSE CHARACTERISTICS OF KEY LAND AND SEA COVER TYPES INCLUDING FORESTS, RANGELAND, CROPLAND, AND LAND, DEEP SEA, VEGETATED SEA LIFE. FOR EACH PRINCIPLE COVER TYPE AN EXTENSIVE DATA BASE WILL BE DEVELOPED VARYING SPECTRAL DOMAIN (REFLECTIVE AND EMISSIVE) AND ILLUMINATION SOURCE (ACTIVE,PASSIVE) AS A FUNCTION OF SUN ANGLE, VIEW ANGLE (IE. ASPECT ANGLE, POLARIZATION ANGLE AND TIME OF DAY (DAY/NIGHT) FOR EMISSIVE REGION. THESE DATA WOULD BE USED TO DETERMINE WHETHER ANY HERETOFORE UNEXPLOITED FEATURE OF LAND COVERS MAY BE PRESENT AND UTILIZED FOR ASSESSMENT OR IDENTIFICATION OF COVER TYPE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km LEO Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.50 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1	10.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 20 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
THE MAJOR OBJECTIVE IS TO ESTABLISH A MUCH NEEDED DATA BASE OVER A WIDE RANGE OF COVER TYPES UNDER BROAD VARIETY OF VIEWING CONDITIONS AND MEASUREMENT APPROACHES SO AS TO ESTABLISH A DETAILED VIEW OF SCENE CLASSES FROM SPACE. CAREFUL CONSIDERATION NEEDS TO BE MADE REGARDING THE COMPATIBILITY AND GENERAL ACCESSIBILITY F THE CONSTRUCTED DATA BASE TO OTHER GEOGRAPHIC INFORMATION SYSTEMS.

PAYLOAD ELEMENT NAME
LARGE ANTENNA SYSTEMS

CODE
BACX0060

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name A.N. SELLMAN
Address ERIM
PO BOX 8618
ANN ARBOR MI 48107

Telephone 313/994-1200

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
EVALUATE FEASIBILITY OF CONSTRUCTING AND OPERATING LARGE ANTENNAS FOR USE IN HF AND MICROWAVE IMAGING SYSTEMS FOR BROAD RANGE OF EARTH OBSERVATION MISSIONS.

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DESCRIPTION
FABRICATE LARGE ANTENNAS NEAR SPACE STATION AND EVALUATE PERFORMANCE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	0.10
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA (X) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
LARGE ANTENNAS REQUIRED FOR SPATIAL RESOLUTION IN REAL APERTURE OR PASSIVE IMAGING SYSTEMS. LARGE ANTENNAS WOULD REPRESENT SIMPLICATION OF TECHNOLOGY OVER SYNTHETIC APERTURE SYSTEMS. REQUIRES SPECIAL GROUND SUPPORT FOR TESTING: (1) EXTRA GROUND-BASED PERSONNEL, (2) COORDINATION OF SCHEDULING.
RELIABLE SPACE CONSTRUCTION TECHNIQUES WOULD OBVIOUSLY HAVE TO EXIST.

PAYLOAD ELEMENT NAME
WAVE MONITORING

CODE
BACX0061

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name A.N. SELLMAN
Address ERIM
PO BOX 8618
ANN ARBOR, MI 48107

Telephone 313/994-1200

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
MONITOR WAVE CLIMATE IN COASTAL AREAS FOR USE IN SHIP ROUTING, EVALUATION OF SHORELINE EROSION, DESIGN OF COASTAL STRUCTURES, OFFSHORE DRILLING OPERATIONS, STUDIES OF ENERGY TRANSPORT.

DESCRIPTION
USE EXISTING SAR TECHNOLOGY TO IMAGE OCEAN WAVES AND EXTRACT DIRECTIONAL SPECTRA, AND INTEGRATE INTO ROUTINE MONITORING SYSTEMS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.01 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	1000	0.10	
Standby			( ) Continuous
Peak			
Voltage, V		Frequency, Hz	

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT NAME
OCEAN SURFACE CURRENTS

CODE
EACX0062

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
EVALUATE FEASIBILITY OF MULTIPLE ANTENNA SYNTHETIC APERTURE RADAR (SAR) SYSTEM TO MEASURE DIRECTION AND SPEED (VIA) SIGNAL PHASE CHANGE OF OCEAN SURFACE CURRENTS. USES MIGHT INCLUDE SHIP ROUTING, CLIMATES STUDIES.

DESCRIPTION
DESIGN AND CONSTRUCT EQUIPMENT AND EVALUATE PERFORMANCE OF CURRENT MEASUREMENT TECHNIQUE BY COMPARISON WITH IN SITU (SEA SURFACE) MEASUREMENTS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.01 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	10.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
REQUIRES ANTENNA SEPARATION OF /100 METERS ON STABLE PLATFORM, WITH ACCURATE MEASUREMENTS OF PLATFORM ATTITUDE. CONCEPT BASED ON WORK OF RANEY (E.G. IEEE TRANS. AES-7, 499, 1971) AND PROVEN MTI TECHNIQUES, BUT NEEDS SIGNIFICANT DEVELOPMENT.

PAYLOAD ELEMENT NAME
MINERAL EXPLORATION

CODE
BACX0063

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
OBTAIN SPECIAL COVERAGE OF POTENTIAL MINERAL EXPLORATION SITES.

DESCRIPTION
OBTAIN COVERAGE OF PROMISING SITES FOR OIL AND MINERAL EXPLORATION TO SUPPLEMENT EXISTING COVERAGES BY AERIAL PHOTOGRAPHY OR LANDSAT SENSORS. ADDITIONAL COVERAGE WOULD USE SYNTHETIC APERTURE RADAR, SPECIAL SPECTRAL BANDS OF MULTISPECTRAL SENSORS, COVERAGE AT SPECIAL SUN ANGLES OR VIEW ANGLES, OR OTHER TEST CONDITIONS LIKELY TO REVEAL FEATURES NOT VISIBLE IN EXISTING COVERAGE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1	10.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions

PAYLOAD ELEMENT NAME
AGRICULTURAL CROP MONITORING

CODE
BACX0064

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
COLLECT BASIC DATA TO SUPPORT FUTURE OPERATIONAL USE OF REMOTE SENSING FOR MONITORING TROPICAL CROP CONDITION AND PRODUCTION.

ORIGINAL PAGE IS OF POOR QUALITY

DESCRIPTION
COLLECT AND ANALYZE BASIC DATA ON SPECTRAL CHARACTERISTICS OF TROPICAL CROPS (AS FUNCTION OF CROP TYPE, PHENOLOGY, SUN ANGLE, VIEW ANGLE, ATMOSPHERIC CONDITIONS). COLLECT ASSOCIATED GROUND TRUTH OVER TEST SITES TO RELATE SPECTRAL DATA TO CROP AREA AND YIELD. OPTIMIZE SPECTRAL BANDS AND/OR SENSOR INSTRUMENTATION FOR CROP CLASSIFICATION. EXPERIMENT WITH USE OF SYNTHETIC APERTURE RADAR FOR CROP CLASSIFICATION. IMPORTANT CROPS INCLUDE CORN, SOYBEANS, SUGAR CANE, AND COFFEE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes ( ) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.01 Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	0.10
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
COVERAGE MAY BE COMPARED TO OR COORDINATED WITH OTHER SATELLITE DATA.

PAYLOAD ELEMENT NAME
AGRICULTURAL CROP MONITORING

CODE
BACX0065

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
COLLECT BASIC DATA TO SUPPORT FUTURE OPERATIONAL USE OF REMOTE SENSING FOR MONITORING TROPICAL CROP CONDITION AND PRODUCTION.

ORIGINAL PAGE IS OF POOR QUALITY

DESCRIPTION
COLLECT AND ANALYZE BASIC DATA ON SPECTRAL CHARACTERISTICS OF TROPICAL CROPS (AS FUNCTION OF CROP TYPE, PHENOLOGY, SUN ANGLE, VIEW ANGLE, ATMOSPHERIC CONDITIONS). COLLECT ASSOCIATED GROUND TRUTH OVER TEST SITES TO RELATE SPECTRAL DATA TO CROP AREA AND YIELD. OPTIMIZE SPECTRAL BANDS AND/OR SENSOR INSTRUMENTATION FOR CROP CLASSIFICATION. EXPERIMENT WITH USE OF SYNTHETIC APERTURE RADAR FOR CROP CLASSIFICATION. IMPORTANT CROPS INCLUDE CORN, SOYBEANS, SUGAR CANE, AND COFFEE

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 320 Perigee, km Tolerance + -
Inclination, deg 28.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.50 Field of View (deg) 20.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1	10.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
COVERAGE MAY BE COMPARED TO OR COORDINATED WITH OTHER SATELLITE DATA.

PAYLOAD ELEMENT NAME
FOREST MONITORING

CODE
BACX0066

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
COLLECT BASIC DATA TO SUPPORT FUTURE OPERATIONAL USE OF REMOTE SENSING FOR MONITORING TROPICAL FORESTS FOR SPECIES IDENTIFICATION, BIOMASS ESTIMATION, CHANGE DETECTION.

ORIGINAL PAGE IS OF POOR QUALITY

DESCRIPTION
COLLECT AND ANALYZE BASIC DATA ON SPECTRAL CHARACTERISTICS OF TROPICAL FOREST AREAS (AS A FUNCTION OF FOREST SPECIES, SEASON, SUN ANGLE, VIEW ANGLE, ATMOSPHERIC (CONDITIONS). COLLECT ASSOCIATED GROUND TRUTH OVER TEST SITES TO RELATE SPECTRAL DATA TO FOREST SPECIES AND CONDITION. OPTIMIZE SPECTRAL BANDS AND/OR SENSOR INSTRUMENTATION, EXPERIMENT WITH USE OF SYNTHETIC APERTURE RADAR OR OTHER ON-BOARD SENSORS FOR FOREST MONITORING. IMPORTANT FEATURES TO MONITOR ARE FOREST SPECIES, BIOMASS, DAMAGE DUE TO DISEASE, INSECTS, OR DROUGHT, CHANGE DUE TO DEFORESTATION, FIRE DISEASE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 320 Perigee, km Tolerance + -
Inclination, deg 28.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.50 Field of View (deg) 20.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC
Power, W Duration, Hrs/Day

Operating
Standby ( ) Continuous
Peak
Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill											
Level											
Hours/Day											

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
COVERAGE MAY BE COMPARED TO OR COORDINATED WITH OTHER SATELLITE DATA.

PAYLOAD ELEMENT NAME
SHADOW AIDED TARGET DISCRIMINATI

CODE
BACX0067

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

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Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
TO ESTABLISH THE UTILITY OF BIDIRECTIONAL (MULTI-ASPECT) MEASUREMENTS OF AGRICULTURAL TARGETS TO EXPLOIT VARIATIONS IN SHADOWING AS A FEATURE FOR DISCRIMINATION.

DESCRIPTION
VARIOUS AGRICULTURAL TARGETS WILL DIFFER IN PHYSICAL STRUCTURE WHICH WILL RESULT IN DIFFERENT SHADOWING CHARACTERISTICS. THESE CAN BE EXPLOITED THROUGH MULTI-ASPECT VIEWING OF THE TARGET PROVIDING ADDITIONAL FEATURES FOR DISCRIMINATION. IT HAS BEEN HYPOTHESIZED THAT WHEAT, BARLEY AND OATS MAY BE DISCRIMINATED USING THIS FEATURE WHEREAS SPECTRAL FEATURES DO NOT SUPPORT DISCRIMINATION. AN AGRICULTURAL PLOT CONTAINING VARIOUS GRAINS WILL BE IDENTIFIED, GROUND MEASUREMENTS TAKEN AND VIEWED FROM SPACE BY VARYING VIEW ANGLE FOR FIXED SUN ANGLES USING USUAL SPECTRAL BANDWIDTHS. THE DATA WILL BE CHARACTERIZED AS A FUNCTION OF THE SHADOW FEATURE.

ORIGINAL PAGE IS OF POOR QUALITY

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 320 Perigee, km Tolerance + -
Inclination, deg 28.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar (X) Earth ( ) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec 0.50 Field of View (deg) 20.00
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	10.00
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: · Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

( ) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remo··
T·/Function ( ) Pressurized ( ) Unpressurized
Length: meters Width: meters Height: meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 20 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions

A WELL CONTROLLED PLOT CONTAINING WHEAT AND BARLEY AT A MINIMUM (OR TWO OTHER SPECTRALLY SIMILAR, STRUCTURALLY DIFFERENT CROPS) SHOULD BE MAINTAINED AND GROUND MEASUREMENTS TAKEN OF SHADOW DIRECTION AND MAGNITUDE AS SPACE OBSERVATIONS ARE MADE.

7.1.5 Life Sciences

7.1.5.1 Life Sciences Research Program

3.1.5 Life Sciences

Man's decision to participate directly in space missions requires that biological effects be understood. Space flights to date have demonstrated that man undergoes physiological and biological functional changes. The relatively short missions to date have not demonstrated irreversible biological affects. The longer duration flights, incumbent in manned permanent space facilities, require that man's long term reaction to the space environment be more fully delineated.

The dual approaches of manned medical research and broad spectrum biological research offer a means to understanding the biology of space flight. The biological research can develop necessary data or physiological changes, over an extended period, without endangering humans. The lessons learned in biological experiments can be used as a base from which to design safe long-term medical research experiments. The joint results from medical and biological research may contribute to the development of a truly closed ecological system in space.

Not all biological research needs to be in direct support of "man in space." The areas of botany, microbiology and exobiology all may benefit from work in zero g. The potential exists to develop new species of plants with superior qualities. The ability to synthesize medically useful material from cell cultures may be enhanced. The search for "organic" molecules in space can contribute to evaluation of the existence of extraterrestrial life.

3.1.5.1 Life Science Research Program

Life science research objectives were identified in two steps. First, we reviewed NASA and periodical literature. Second, we contacted life scientists interested in space research. From these sources we developed mission analysis user forms in Section 3.1.5.3 (Vol. 7) which identify life sciences objectives. We found these objectives to fall into three broad inter-related mission areas. First, was medical research aimed at identification and control of adverse zero g affects on humans. Second was biological research in the fields of zoology, botany, microbiology and exobiology, that studied basic life processes and supported medical research. The third area was the controlled ecological life support system (CELSS) aimed at developing a simplified ecological balance permitting long duration space missions with minimum earth resupply. Table 3.1.5-1 lists

Table 3.1.5-1. Life Science Mission Areas

Mission Area:	Objective Areas:
Human Medical Research	Cardiopulmonary system Body Fluid systems Sensory Systems Musculoskeletal system
Biological Research	Medical Related Studies Metabolic Studies Radiation Studies Animal Development Studies Animal Reproduction Plan Development Studies Plant Reproduction Studies Microbiological Studies Exobiology
Controlled Ecological Life Support System (CELSS)	Plant/Animal Interface Plant/Facility Interface Animal/Facility Interface Mechanical LSS Functions Microbial Role in CELSS Human Role in CELSS

these mission areas with their respective scientific objectives as identified from our research.

The objectives of each identified life science experiment was reviewed to determine inspace flight duration requirements. Those experiments that require less than thirty days in orbit were considered as short term research suitable for the STS. Those experiments exceeding thirty days were further examined for compatibility with the Space Station. A schedule was developed that integrated projected life science budgets with the needs for medical research, "pure" scientific research, and the CELSS developmental requirements. The three research categories were then scheduled over a 15-year period to determine emphasis to be given to each category in a given year. (Figure 3.1.5-1)

The development of time lines for the diverse research categories permitted definition of support facilities. Six types of support facilities were identified as applicable to life sciences or the Space Station. These are: (1) medical; (2) suitcase; (3) space available facility; (4) dedicated Life Sciences Research Facility (LSRF); (5) research centrifuge facility and, (6) dedicated Controlled Ecological Life Support System facility. The following paragraphs briefly describe each of these levels of research.

Medical Facility. Medical research will be conducted with the facilities that are provided for in the health facility. The Health Maintenance Facility described for the Space Station will supply the instrumentation and equipment for human medical research. In addition, facilities will be available for the analyses of samples to be conducted onboard the Space Station. Due to the nature of medical research, the level of effort will be controlled by crew involvement, since crew members will act as both subjects and researchers.

Suitcase Facility. For this study, we have defined suitcase experiments as being automated, fully contained, carry-on packages. These packages would be small enough to be carried through the Shuttle or Space Station hatches. The experiments could be manifested for Shuttle flights or carried aboard the Shuttle to the Space Station during Shuttle visits on a space available basis. The packages would be completely self-contained with the exception of power and thermal control which would be supplied by the Space Station. Crew involvement would be minimal, requiring only starting and stopping the experimental cycle. These experiments would be set up on the ground before flight and returned to the ground for analysis.

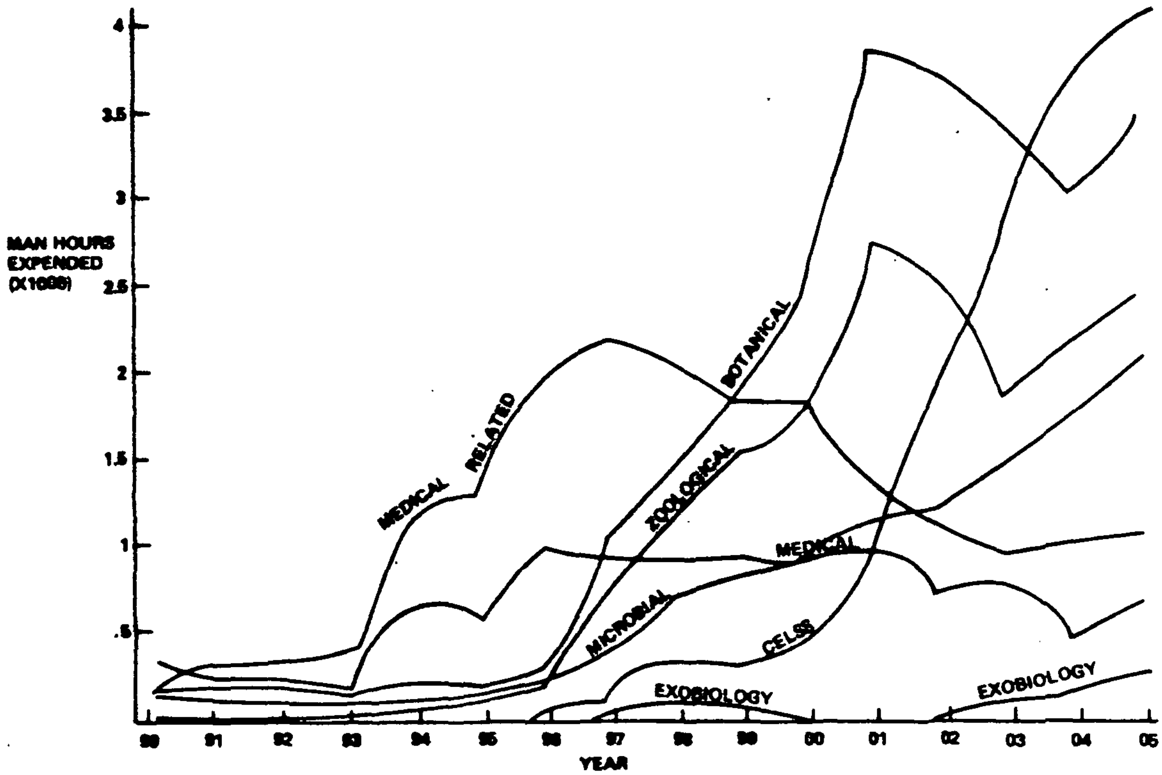

Figure 3.1.5-1 Manhours Expended on Life Sciences Dicipline Onboard Space Station

Space Available Facility. Space available experiments are defined as ones that are less automated (i.e., require crewtime for operations) or are larger than a suitcase package. The facilities could be at least partially assembled at the Space Station and the experiments set up by the crew. The name comes from the connotation of their being fitted into some unused space at the Station. The types of experiments that can be considered for this category include plant research, cell and tissue research, invertebrate research, and advanced EC/LS and EVA testing. Higher animal research would be limited by concerns of contamination hazard to the Station habit modules.

Dedicated Life Sciences Research Facility. A dedicated facility for life sciences research would house a fully equipped research laboratory. The facility could be a modified Spacelab or some other module docked to the Station. The research facility would have its own EC/LS equipment and power source. A full research program, including animal and CELSS related research could be carried out in the facility.

Research Centrifuge Facility. A research centrifuge facility would house a centrifuge for purposes of conducting gravitational biology experiments. Centrifugal forces would be provided from the nominal microgravity environment through the 1.0g range. A modified short spacelab module may be adequate to contain the centrifuge. The centrifuge module would contain the necessary instrumentation for one g simulation. The life sciences research facility would be necessary to conduct the other research activities associated with gravitational biology.

Dedicated Controlled Ecological Life Support System Facility. The CELSS module would be an additional module docked to the Station. This facility could be a duplicate of the life sciences facility but would be dedicated to integrating the biological, environmental control and life support functions into a full-sized test bed, eventually including man. The philosophy being that if something goes wrong while testing a CELSS, the crew would move into the Station and the CELSS module would be isolated without endangering crew members.

Implicit in these designs were certain assumptions.

a) Short-term affects of the space environment will be developed during STS flights except when facilities or protocols cannot be attained by the Shuttle system.

b) Experiments will proceed by a stepwise evolutionary progression. Therefore, it is not productive to model or describe individual experiments at this time.

c) The Space Station will operate in low Earth orbit at a low Inclination.

d) Life science research will not start until the station is continuously inhabited in a four man configuration.

e) Safety concerns of fire, depressurization, et al., are included in station design.

f) Space Station will be modular in growth supported by the STS or its successor.

g) EVA will be routinely conducted in an eight psi suit.

h) Personnel stay time will be three months with possible extension by volunteers.

i) Gravity levels will not exceed an average of 10^{-5}g with transients not to exceed 10^{-3}g.

The combination of facility types, Life Science budget, and priority emphasis resulted in a facility time line as a function of total life science effort (Figure 3.1.5-2). Manpower available for life sciences was determined by extrapolating station manning and work load. The resulting graph (Figure 3.1.5-3) predicts a low initial life science manhour expenditure followed by modest growth. The application of the objective time line to research facility generates a facility usage scenario (Figure 3.1.5-4).

Potential Instrumentation

A variety of laboratory equipments is required to support life science research. The support facility concept proposed above is the media for introduction of this equipment. The suitcase concept can be used to deliver equipment instead of experiments. This type of equipment delivery would be especially applicable to medical research activities. The space available concept would deliver modules containing specific research equipment along with experiments. At the end of the experiment the equipment would be retained at the station. The LSRF, centrifuge and CELSS facility would continue this accumulation of laboratory equipment. The net result would be a totally instrumented Space Station

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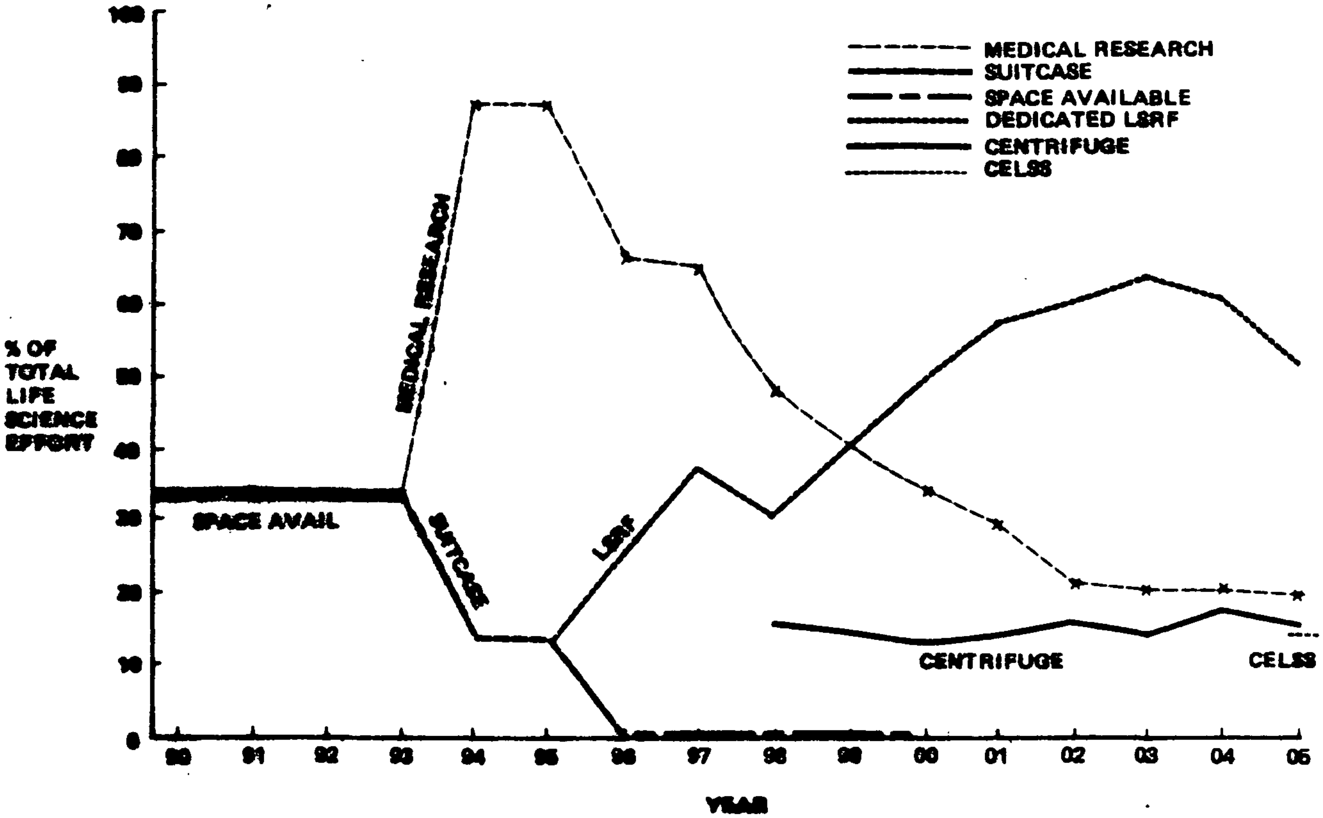

Figure 3.1.5-2 Life Science Effort by Facility

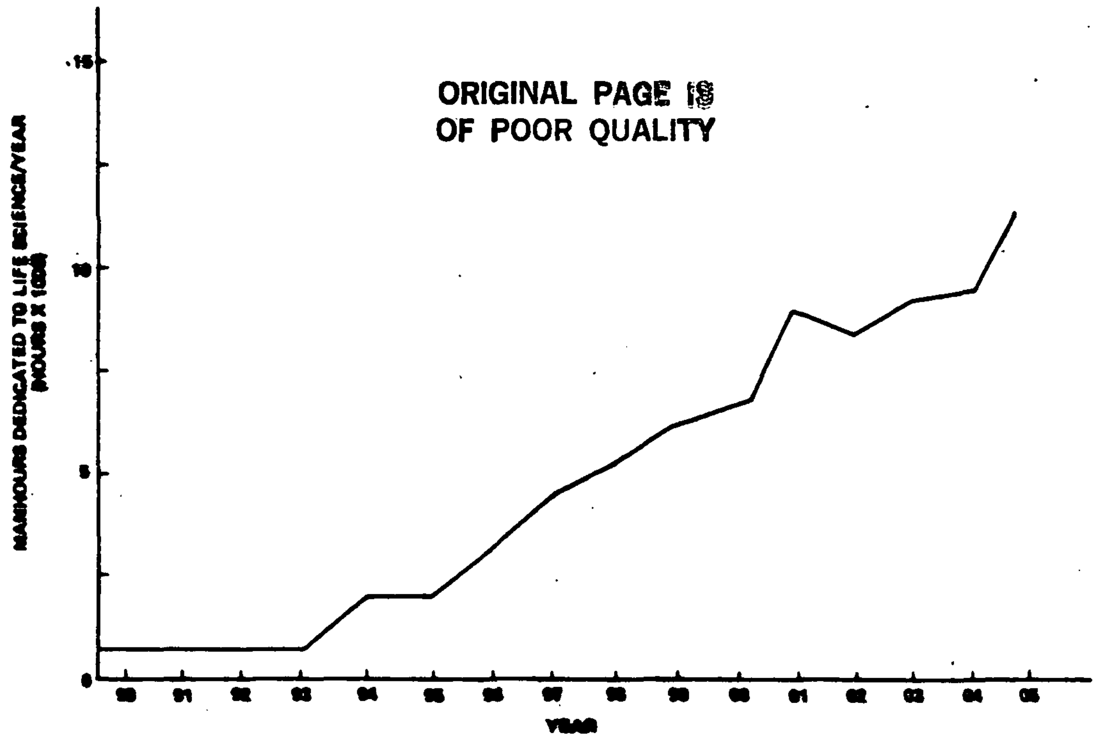

Figure 3.1.5-3 Available Man Power

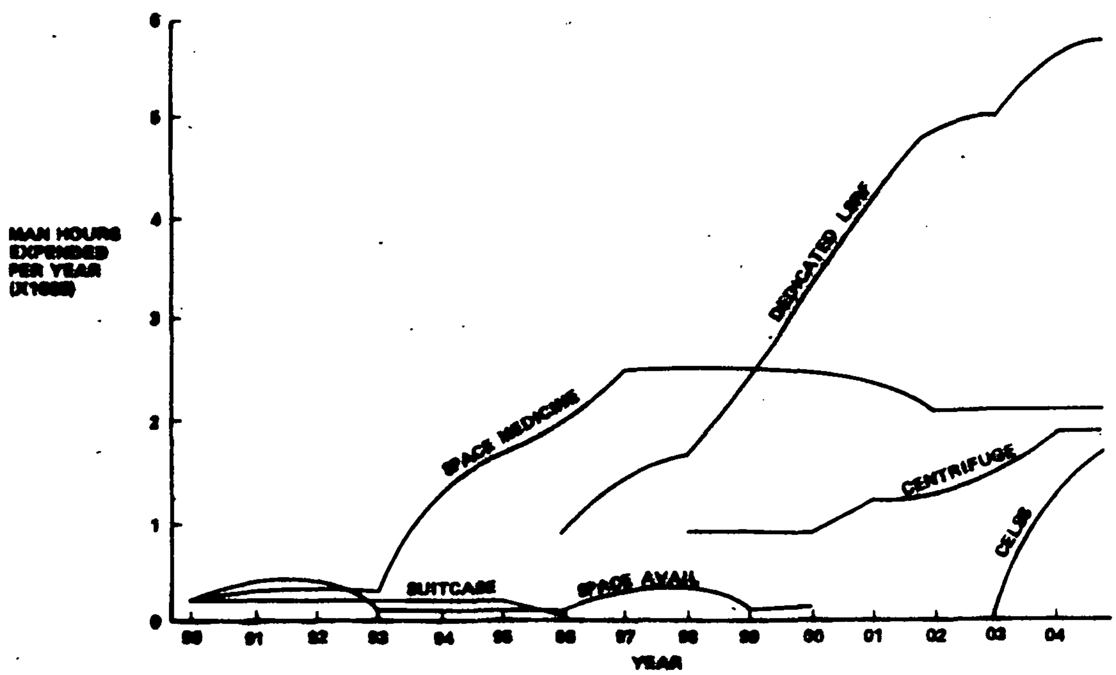

Figure 3.1.5-4 Facility Usage Scenario

equivalent to the "CORE" listings of the Blue Book (Ref. 11). Our proposed equipment list for the Space Station is shown in Figure 3.1.5-5. We have rated each item as to its criticality for each experiment objective (Figure 3.1.5-6). The integration of the life science objectives time line with the equipment needs resulted in a proposed equipment delivery schedule (Figure 3.1.5-7).

Assumptions were made that: 1) The same piece of equipment would not be used for both human and animal experiments to avoid cross contamination; 2) once an item of equipment is at the Space Station it will remain in place to service following experiments; and 3) experiment unique instrumentation/equipment will be inclusive in the individual experiment package.

The use of a manned Space Station has several advantages in instrumentation for life sciences.

1) The cost per unit can be lowered through reduction in equipment automation.

2) Equipment cost and mass can be reduced by lowering reliability standards due to availability of repairmen.

3) The accuracy of instruments can be verified through calibration on-orbit.

4) Instrumentation can be used to evaluate unexpected and episodic events.

5) The equipment can be used through a succession of experiments with human reconfiguring the devices as required.

6) Some procedures such as automated dissection and blood drawing are not feasible with current or foreseeable technology.

Facility Payload

The development of life science experiments requires recognition of the Space Station's modular growth pattern. We have developed our life science support facilities to conform to station capability. This is beneficial to the Life Sciences in that it allows experiments to build on prior results.

Figure 3.1.5-5. Life Sciences Equipment List*

601 Air Particle Sampler
602 Alpha Particle Analyzer
603 Arterial Pressure Recorder
604 Audiometer
605 Autoradiograph
606 Behavioral Evaluation Equipment
607 Blood Chemistry Analysis Unit
608 Blood Gas Analyzer
609 Bottles/Dishes/Test Tubes (labware)
610 Camera, still
611 Cardiograph Impedance/Phono
612 Centrifuge Highspeed
612 Centrifuge Micro
614 Centrifuge (one-g)
615 Chemistry Analysis Set
616 Cryogenic System
617 Data Management Unit
618 Dehydrated Growth Media
619 Dental Instrument Kit
620 Dessicator (Vacuum)
621 Diagnostic X-ray
622 Dissection Tools
623 Doppler Flowmeter
624 Dosimeters
625 Dynamometers
626 ECG/EVG
627 EEG
628 Electrophoresis
629 EMG
630 EOG
631 Filtering Apparatus
632 Freezers
633 Gas Chromatograph
634 Histology Section Kit
635 Holding Facilities
636 Incubator
637 Injectable Drug Equipment
638 IV Fluids Administration System
639 Laminar Flow Table
640 Limb Plethysmograph
641 Lower Body Negative Pressure Unit
642 Lyophilizer
643 Mass Measurement Device Macro
644 Mass Measurement Device Micro
645 Mass Spectrometer
646 Metabolic Analyzer
647 Microbiology Kit
648 Microtome
649 Micro Manipulator
650 Microscope Stereo
656 Microscope Electron
652 Microscope Light
653 Ohmmeter
654 Oscilloscope
655 Oven
656 PH Meter
657 Physiological Gas Analyzer
658 Plant Tools
659 Plate Scan Counter
660 Polargraphic CO_2 Sensor/O_2 Sensor
661 Preservation Fluids/Material
662 Pulmonary Function Measurement Unit
663 Psychometrics Unit
664 Radiobiology Unit
665 Refrigerator
666 Rotating Litter Chair
667 Sample Preparation/Fixation Kit
668 Stains
669 Sterilizer
670 Signal Generator
671 Surgical Instrument Kit
672 Temperature Block
673 Timer/Clock
674 Tissue Culture Chamber
675 Trace Gas Monitor
676 TV/Video/Cinematography
677 Urine Analyzer
678 Veterinary medical Kit
679 Voltmeter
680 Washer Cage
681 Washer Instrument, Tools

* Numbers on figure refer to codes for payload manifesting program.

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Figure 3.1.5-6. Criticality of Life Sciences Equipment to Experiments

Life Sciences Objective Areas / Life Sciences Equipment	Air Particle Sampler	Alpha Particle Analyzer	Arterial Pressure Recorder	Audiometer	Autoradiograph	Behavioral Evaluation Equipment	Blood Chemistry Analysis Unit	Blood Gas Analyzer	Bottles/Dishes/Test Tubes (Labware)	Camera, Still	Cardiograph Impedance/Phono	Centrifuge Highspeed	Micro	Centrifuge One-g	Chemistry Analysis Set	Cryogenic System	Data Management Unit		Dehydrated Growth Media	Dental Instrument Kit	Dessicator (Vacuum)		Diagnostic X-ray	Dissection Tools	Doppler Flowmeter	Dosimeters	Drying Oven	Dynamometers	ECG/VCG	EEG	Electrophoresis	EMG	EOG	Filtering Apparatus	Freezers	Gas Chromatograph	Glove Box	Histology Section Kit	Holding Facilities	Incubator	Injectable Drug Equipment	IV Fluids Administration System	Laminar Flow Table	Limb Plethysmograph	Lower Body Negative Pressure Unit	Lyophilizer	Mass Measurement Device Macro	Micro		Mass Spectrometer
Human																																																		
Cardiopulmonary System																																																		
Heart			A								A						B						C		C			B	A	D											B	C			B					
Lung	C																B						B		C			B		B		B				D					B	C								
Vascular			A								B						B						C		B			B	B												A	B		B						
Body Fluids Systems																																																		
Cellular Fluids			A		C				A	B		A	B		A	A	A		D		C		C				D				C			A	A	B	B			D	C	C	B			D	D	A		B
Blood			A		C		A	A	A	A		B	A		D	A	A		C		C		B		B		D	B	A		D			A	A	D	B			C	B	B	B			D	D	A		C
Urine					C				A	C		A	B		A	A	A		B		C		B				D							A	A	B	B			C	B	B	B			D	C	A		A
Sensory Systems																																																		
Audio				A		B								C			B						C									B									B	B								
Taste (Gastation)	D					B								C			B			B																					C						B	A		
Smell (Olfactory)						B								C			B						C									C									C									
Touch (Somatosensory)						B								C			B															B	B								D						A	A		
Vision (Ocular)						B				A				C			B						C									C									B	B								
Balance (Vestibular)						A				A				C			B						A							A		C									A	A								
Musculoskeletal																																																		
Anthropometry										A				C			B						C					B		B		C												B	C		A	A		
Musculature										A				C			B						C					B	A	B		A									C	C		A	A		A	A		
Skeletal Systems										A				C			B			C			A					B													C	C					A	A		
Nonhuman																																																		
Bone Loss					C				A	B		C		C	C	B	B			B	D		A	A	A									C	A	C		A	A		B	B	A		D		A	A		B
Muscle Loss					C				A	A		C		C	C		B				D		C		A			C	B			A			A			A	A		B	B	A				A	A		B
Fluids & Electrolytes			C		B		A	A	A	C		A	A	C	A	B	B		C		B		B		A									A	A	B			A		A	A	A		D		A	A		B
Cardiovascular			A		B		A	C	A	C	A	B		C	C		B						B		A			A	A	C		A			A			B	A		A	A	A				A	A		C
Metabolism					B		B	B	A	D	C	B	C	C	B		B											A			D				A	A			A		A	A	B				A	A		A
Vestibular Physiology									A	B		C		C	D		B						C		A					A					A			B	A		B	B	A		D		A	A		C
Vestibular Function									A	B				C	D		C													A					A				A		A	A	C				A	A		
Radiation Biology	D	A			A		B	B	A	C		B		C	B	C	B		A				A		A	A								C	A	B	A	B	A	A	A	A	A							A
Animal Development			C		C		B	B	A	A	C	C		C	C	C	B			C			B		A				D	C		C	C	A	A	C		A	A		B	B	A				A	A		B
Animal Reproduction					D		B	B	A	A	C	D		C	D	B	B						C		A				D	C			C	B	A	C		A	A	A	B	B	A				A	A		B
Plant Physiology		D			B				A	A		A		C	B	C	B								A									A	A	B		A	A				A				A	A		A
Plant Development		D			C				A	A		C		C	D	B	B								A									B	A	C		A	A				A				A	A		A
CELSS	C		D		D		D	D	A	B	D	D		C	C	D	C		B				D		C									A	A	C		C	A		B	C	C			C	A	A		C
Microbiology		C			C				A	A		A	D	D	B	B	B		A		C						B				B			A	A	A	A		A	A			B				A	A		B
Exobiology									A			B			A	B	D																			A	A										C			A

LEGEND

A = Early Research Requirement
B = Growth Phase Research Requirement
C = Mature Phase Research Requirement
D = Nice to have but not a requirement

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Figure 3.1.5-6 (Continued)

Life Sciences Objective Areas \ Life Sciences Equipment	Metabolic Analyzer	Microbiology Kit	Microtome	Micro Manipulator	Microscope	Electron	Light	Ohmmeter	Oscilloscope	Oven	PH Meters	Physiological Gas Analyzer	Plant Tools	Plate Scan Counter	Polargraphic CO_2 Sensor/ O_2 Sensor	Preservation Materials	Pulmonary Function Measure Unit	Psychometrics Unit	Radiobiology Unit
Human — Cardiopulmonary System																			
Heart	B								D										
Lung	B								D			A			D		A		
Vascular																			
Body Fluids Systems																			
Cellular Fluids	B	B			A	C	A	C		C	A			B		A			
Blood	B	B			A	B	A	C		C	A			B		A			
Urine	A	B			D	D	A	C		C	A			B		A			
Sensory Systems																			
Audio									A									A	
Taste (Gastation)																		B	
Smell (Olfactory)																		B	
Touch (Somatosensory)									B									A	
Vision (Ocular)									A									A	
Balance (Vestibular)																		A	
Muscuoskeletal																			
Anthropometry								D	D										
Musculature								C	B										
Skeletal Systems								C	D										
Nonhuman — Bone Loss	C		A	A	A	B	A	C	C	B	B					A			B
Muscle Loss					A	C	A		C	D						A			B
Fluids & Electrolytes	D					D	A	C		B	A					A			B
Cardiovascular	D				A	C	A		B	D	A	A			B	A	B		B
Metabolism	A		B			B	A			B	A	A			B	A			A
Vestibular Physiology					A	C	A			D									
Vestibular Function					A	D	A									A			
Radiation Biology	B		A		A	B	A		C										A
Animal Development	B				A	C	A				B	C			C	A	B		B
Animal Reproduction	B				A	B	A				C	C			C	A			C
Plant Physiology	B				A	C	A	C	C	C	B		A		B	A			B
Plant Development	B				A	B	A	C	C	C	B		A		B	A			B
CELSS	C		B		A	D	A	C	C		B		A	C	B	A			C
Microbiology	B	A			A	B	A			C				A		A			B
Exobiology						A													C

Life Sciences Objective Areas \ Life Sciences Equipment	Refrigerator	Rotating Liter Chair	Sample Preparation/ Fixation Kit	Stains	Sterilizer	Signal Generator	Surgical Instrument Kit	Temp. Block	Timer/Clock	Tissue Culture Chamber	Trace Gas Monitor	TV/ Video/Cinematography	Urine Analyzer	Veterinary Medical Kit	Voltmeter	Washer Cage	Instrument, Tools
Human — Cardiopulmonary System																	
Heart									A								
Lung									A	C	C						
Vascular									A								
Body Fluids Systems																	
Cellular Fluids	A		A	A	A			A	A	B							A
Blood	A		A	A	A			A	A	B							A
Urine	A		A	A	A			A	A	B			A				A
Sensory Systems																	
Audio						A			A			B					
Taste (Gastation)									A			C					
Smell (Olfactory)									A			C					
Touch (Somatosensory)						B			A			B					
Vision (Ocular)						A			A			A					
Balance (Vestibular)									A			A					
Muscuoskeletal																	
Anthropometry		C							A			A					
Musculature		C							A			A					
Skeletal Systems		C										A					
Nonhuman — Bone Loss	A		A	A	B			A	A	C		B	A	A	C	A	A
Muscle Loss	A		A	A	B	C		B	A	C		A	A	A	C	A	A
Fluids & Electrolytes	A		A	A	A			A	A			D	A	A	A	A	A
Cardiovascular	A		A	A	A	C		B	A	C	C	B		A	B	A	A
Metabolism	A				A				A		B	D	A	A		A	A
Vestibular Physiology	A		A	A	C	D			A			C		A		A	A
Vestibular Function	A				C	C			A			A		D		A	A
Radiation Biology	A		A	A	A				A	A		C	B	A		A	A
Animal Development	A		A	A	A			B	A	C		A	A	A		A	A
Animal Reproduction	A		A	A	A			B	A	B		A	A	A		A	A
Plant Physiology	A		A	A	A	C		B	A	B		A			C	A	A
Plant Development	A		A	A	A	C		B	A	B		A			C	A	A
CELSS	A		A	A	A	D		C	A	B	A	A		C	C	A	A
Microbiology	A		A	A	A			A	A	A	C	B					A
Exobiology				C	B							C					

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Figure 3.1.5-7. Laboratory Equipment Delivery Schedule

YEAR	EQUIPMENT	
1990	Arterial blood pressure recorder	Blood chemistry unit
	Labware	Blood gas analyzer
	Still camera	Freezer
	Micro mass measurement device	Macro mass measurement device
	Psycometrics test kit	Refrigerator
	Specimen stains	Clock/timer
	Tissue/Microbial culture chamber	Urine analyzer
	Microscope (light)	Microscope (Stereo)
1991	Data management unit	Doppler flow meter
	Dynamometer	ECG/EVG
	Sample preservation kit	Video/TV/cinematography
1992	Metabolic analyzer	Sterilization system
	Limb plethysmograph	Lower body neg pressure unit
1993	Micro centrifuge	EMG
	Filtering Apparatus	Gas Chromatograph
	Glove box	Animal/plant holding facility
	Microbial Incubator	Drug injection kit
	IV fluid injection kit	Pulmonary function measure
	Dissection instruments	Cage/instrument washer
1994	Spectrophotometer	
1995	High-speed centrifuge	Chemical analysis set
	Cryogenic system	Dehydrated growth media
	X-ray	Histology kit
	Laminar flow table	Microbiology kit
	Microtome	Micro manipulator
	PH meter	Plate scan counter
	Temperature control block	Veterinary medical kit
	EEG	Electrophoresis device
1996	Physiological gas analyzer	Audiometer
	Behavioral evaluation kit	Dental instruments
	Radiobiology (isotope) unit	Dosimeter
	Ohm meter	
1997	Polargraphic O_2/CO_2	Vacuum Desiccator
	Plant Culture tools	
1998	Autoradiograph	1g centrifuge
1999	Nuclear magnetic resonance Imager	
	EOG	
	Electron Microscope	Oscilloscope
2000	Signal generator	Rotating litter chair
2001	Alpha Particle Analyzer	
2002	Lypholizer	Drying oven
2003	Trace gas monitor	Voltmeter
2004	Air particle sampler	Decompression chamber

We expect that the life science objectives will follow the pattern outlined in Figure 3.1.5-1. The initial goals must be to study the effects on man of long-term exposure to space environment. Early experiments will emphasize space medicine and medically-related studies on experimental animals (rats, mice etc.). A low-level effort will be in place to examine plant physiology, microbial growth and animal development. The concentration on medical research will prevail for about five years.

The controlling factor in early medical research will be the manning level and time available for crew involvement. We expect that the 2-3 man station medical research will be based on suitcase type experiments. Most of these early experiments will monitor the crew's basic biological functions at various levels of stress/exertion. The biological research would also be of the suitcase variety with all necessary instrumentation integral. The constraining factors will be specimen size, ECLSS requirements, and automation capability. These experiments will be periodically returned to earth.

As the Space Station matures, incremental growth of the life science capabilities are expected. We anticipate that by 1992 a space available life science research module will have been delivered. This module will possess improved life science facilities that would reduce the constraints imposed by "suitcase" experiments. Module supported medical research will have improved monitoring equipment allowing a greater range of objectives to be examined. Non-human research will improve due to superior habitates, more and better instrumentation and the introduction of humans in the experiment loop. Facility size, equipment, man availability and contamination control will impose experimental constraints. Suitcase experiments will continue to be used as a research tool.

A major milestone will be achieved about 1996. The Space Station Life Science Research Facility (LSRF) will be operational. The use of suitcase experiments will decrease to a minimal level. Space available equipment will be incorporated into the LSRF. The space station will then possess the necessary environment to conduct all phases of non-human experiments except artifical G. The constraints will be man availability and "science knowledge data base." At this point, the relative effort on medical research will decline, (Figure 3.1.5-2) although hours expended will be near constant (Figure 3.1.5-1). The life sciences will increasingly emphasize research into organism development, physiology and reproduction. Plant and microbial studies will receive careful attention as to their commercial and CELSS potential.

Table 3.1.5-2. Suitcase Facility Requirements for Plants Studies

Power (Electric):

A.C.	NA	Volt Average	NA Watts	Peak	Watts
D.C.	28	Volt Average	250 Watts	Peak	278 Watts

Heat Rejection: Average 250 Watts Peak 278 Watts

Mass: 61.7 (kg)

Dimensions/Volume: 65 cm (Long) 65 cm (Wide) 40 cm (High) 1.11 m^3 (Volume)

Temperature: Range 10-38°C Average 24 ± 2.5°C

Atmospheric Pressures:

atm	760 ± 20 mmHg	O_2	150 ± 10 mmHg
N_2	TBD mmHg	CO_2	3.9 ± 3.7 mmHg
H_2O	15 ± 3 mmHg	NH_3	TBD mmHg

Relative Humidity: TBD (%)

Air Velocity TBD (m/sec)

Lighting: On-Cycle: 0-100 (%)
Intensity (ft cndls) Range 10 - 400; Avg 102 ± 10
Frequency (nm) Range 400 - 500 and 600 - 700

Noise (dB): 130 maximum

Gravity: (g) 10^{-5} 95% of time; 10^{-3} maximum during maneuvers

Specimen	Size	Vol/Specimen	Qty
a) Vigna sinensis	10x10x25 cm	26 cm^3	96
b) Bagettes minutum	10x10x25 cm	26 cm^3	32
c) Arabidopsis	10x10x25 cm	26 cm^3	32
d) Pteris (gametophyte cycle)	10x10x25 cm	26 cm^3	32
e) Garden pea	10x10x25 cm	26 cm^3	32

Data Management

Channels:	Total 18 multiplex Leads, 4 Channels per specimen
Data Form:	Analog 50%, Digital 50%
Data Rates:	Analog 1k bps/chnl, Digital 1k bps/chnl
Video/TV:	Yes

Contamination Control

a) Atmospheric isolation by use of "dust filters" adequate.
b) Common water supply, with antiback flow device, is acceptable.

Table 3.1.5-2. Suitcase Facility Requirements for Plants Studies

Power (Electric):

A.C.	NA	Volt Average	NA Watts	Peak	Watts
D.C.	28	Volt Average	250 Watts	Peak	278 Watts

Heat Rejection: Average 250 Watts Peak 278 Watts

Mass: 61.7 (kg)

Dimensions/Volume: 65 cm (Long) 65 cm (Wide) 40 cm (High) 1.11 m^3 (Volume)

Temperature: Range 10-38°C Average 24 ± 2.5°C

Atmospheric Pressures:

atm	760 ± 20 mmHg	O2	150 ± 10 mmHg
N2	TBD mmHg	CO2	3.9 ± 3.7 mmHg
H_2O	15 ± 3 mmHg	NH_3	TBD mmHg

Relative Humidity: TBD (%)

Air Velocity TBD (m/sec)

Lighting: On-Cycle: 0-100 (%)
Intensity (ft cndls) Range 10 - 400; Avg 102 ± 10
Frequency (nm) Range 400 - 500 and 600 - 700

Noise (dB): 130 maximum

Gravity: (g) 10^{-5} 95% of time; 10^{-3} maximum during maneuvers

Specimen	Size	Vol/Specimen	Qty
a) Vigna sinensis	10x10x25 cm	26 cm^3	96
b) Bagettes minutum	10x10x25 cm	26 cm^3	32
c) Arabidopsis	10x10x25 cm	26 cm^3	32
d) Pteris (gametophyte cycle)	10x10x25 cm	26 cm^3	32
e) Garden pea	10x10x25 cm	26 cm^3	32

Data Management

Channels:	Total 18 multiplex Leads, 4 Channels per specimen
Data Form:	Analog 50%, Digital 50%
Data Rates:	Analog 1k bps/chnl, Digital 1k bps/chnl
Video/TV:	Yes

Contamination Control

a) Atmospheric isolation by use of "dust filters" adequate.
b) Common water supply, with antiback flow device, is acceptable.

Table 3.1.5-2 (Continued)

NOTES:

1) Unit fits into space lab/Shuttle storage cabinet racks.

2) Support facility provides power, water, atmosphere and heat rejection.

3) Provisions will be made for unit to support plant life during transfer from/to Shuttle and Station or during temporary power loss.

4) Light source will have minimal mercury level that provides adequate light intensity in required frequency ranges.

5) Water consumption will be monitored.

6) Unit will be transportable through 40 inch Shuttle/Station hatch.

7) Specimens will be monitored by on-board data management system. Data will be stored for daily transmission to ground facilities. System signals will be multiplexed when possible.

Table 3.1.5-3. Suitcase Facility Requirements For Cell and Tissue Studies

Power (Electric):

A.C.	NA Volt	Average	NA Watts	Peak	NA Watts
D.C.	28 Volt	Average	16 Watts	Peak	256 Watts

Heat Rejection — Average 16 Watts — Peak 256 Watts

Mass: 10.09 (kg)

Dimensions/Volume: 19 cm Long 39.4 cm wide 16.5 cm high 1 m^3 volume

Temperature: Range 5 to 60°C Average 37°C ± 1.8

Atmospheric Pressure: ATM mmHg N_2 600 ± 20 mmHg O_2 160 ± 5 mmHg CO_2 3 mmHg

Relative Humidity: Range 60 - 100 (%) Average 95 ± 5%

Air Velocity: TBD (m/sec)

Lighting: On-Cycle: 0-100%
Intensity (Ft Cndls) TBD
Frequency (nm) TBD

Noise (dB): TBD
Gravity (g): 10^{-5} 95% of time; 10^{-3} 100% of time

Specimen	Size	Vol/Specimen	Qty
a) Microorganisms b) And Tissue c) Cultures	Microscopic	21.53 mL/colony	2000/mm^2

Data Management

Channels	Total 4, per specimen 0
Data Form	Analog 90%, Digital 10%
Data Rates	Analog 400 bps, Digital 40 bps
Video/TV	Yes

Contamination Control:

a) System will be totaly isolated from human atmosphere, and water supply.

Table 3.1.5-3 (Continued)

NOTES:

1) System will possess a capability for the lapse time photography at predetermined magnification levels.

2) A method to add fixative/stain to individual samples will be available.

3) System will be fully automatic.

4) Unit will be designed to fit into Space Lab/Shuttle double rack.

5) Unit is transportable through 40 inch Shuttle/Station hatch.

6) Power, water, atmosphere and heat rejection are provided by support facility.

7) Each unit is capable of maintaining specimen for one hour during transfer to/from space station and in event of power failure.

8) Specimens and mechanisms are monitored by on-board data management systems. Signals are multiplexed when feasible. Monitored data is stored for daily transmission to ground facilities.

Table 3.1.5-4. Suitcase Facility Requirements for Animal Studies

Power (Electric):

A. C.	120	Volt Average	72 Watts	Peak	700 Watts
D. C.	28	Volt Average	265 Watts	Peak	585 Watts

Heat Rejection: Average 387 Watts Peak 1337 Watts

Mass: 256 (kg) with specimens and camera

Dimensions /Volume: 0.76 m Long 1.52 m Wide 1.7 m(High) 2 (Volume)

Temperature: Range 5^o - 60^oC Average 25 ± 1^oC

Atmospheric Pressure:

ATM 760 mmHg	O_2 160 $\pm$ mmHg
N_2 580 $\pm$ 20 mmHg	CO_2 6 mmHg
H_2O 12 $\pm$ 3 mmHg	NH_3 0.01 mmHg
CO 0.01 mmHg	

Relative Humidity: 10 - 80% range 50 $\pm$ 5% typical

Air Velocity: 0.25 $\pm$ 0.03 (m/sec)

Lighting:
On-Cycle (%): 0 - 100
Intensity (Ft Cndls) 0 - 140 range 120 typical
Frequency (nm) 400 - 800

Noise (dB): NC 50

Gravity (g): 10^{-5}g 95% of time not to exceed 10^{-3} during maneuvers

Specimen	Size	Volume/Specimen) (m^3)	Qty
a) Rabbit	1.5kg	$0.025m^3$	6
b) Rat	0.5kg	$0.007m^3$	6
c) Mice	0.11kg	$0.002m^3$	36

Data Management:

Channels:	Total 20, per specimen 4
Data Form:	Analog 75%, Digital 25%
Data Rates:	Analog 1.2 Kbps, Digital 0.4 kbps
Video/TV:	B&W video with downlink dump capability

Contamination Control

a) Air supply contamination is to be isolated from cabin atmosphere either by independent supply/return loops or use of HEPA type filters.
b) Water supply isolated from crew supply.
c) Waste management system captures and contains waste from cabin atmosphere.

Table 3.1.5-4 (Continued)

NOTES:

1) Unit is designed to fit into Skylab/Shuttle double rack.

2) Food will be supplied in form and quantity suitable for automatic disbursement. Quantity of food consumed each day will be recorded.

3) Water consumption rates will be monitored on daily basis.

4) Unit will accept TV/video camera (B&W) to monitor 50% of test specimens.

5) Unit is transportable through 40 inch Shuttle/Station hatches.

6) Power, water, atmosphere and heat rejection are provided by support facility.

7) Each unit is capable of maintaining specimens for one hour during transfer to/from Space Station and in event of power failure.

8) Provisions will exist for restraining each animal.

9) Specimen and mechanism are monitored by on-board data management systems. Signals are multiplexed when feasible. Monitored data is stored for daily transmission to ground facilities.

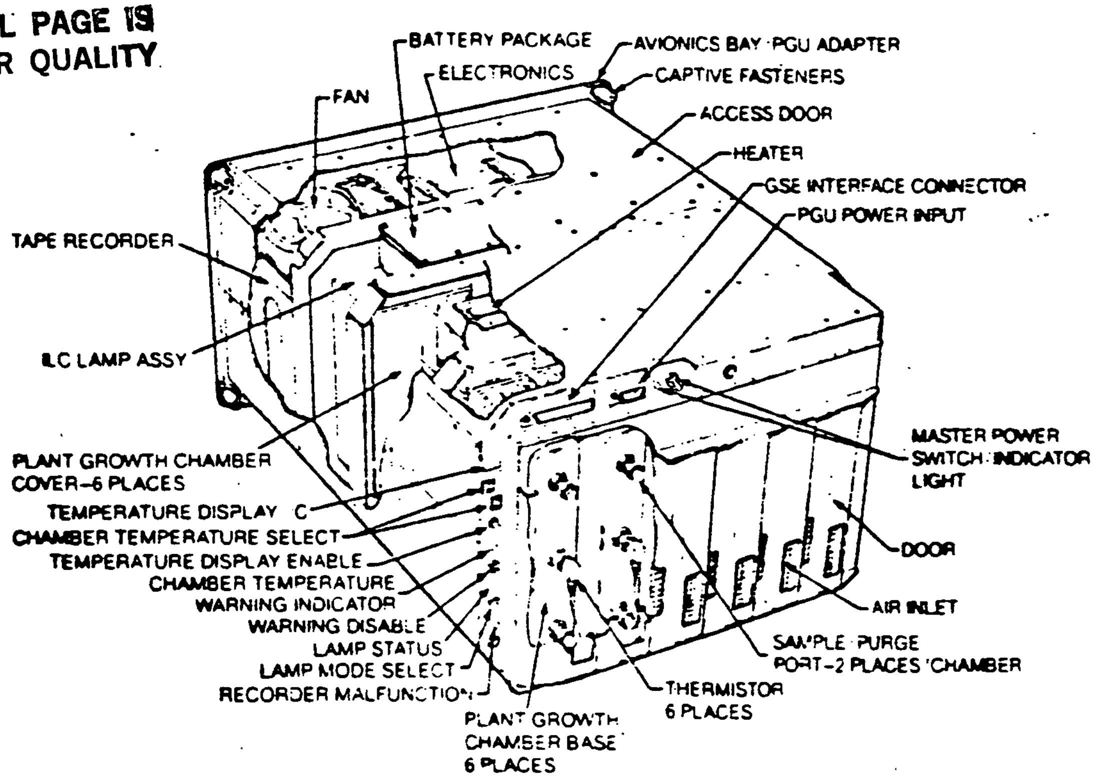
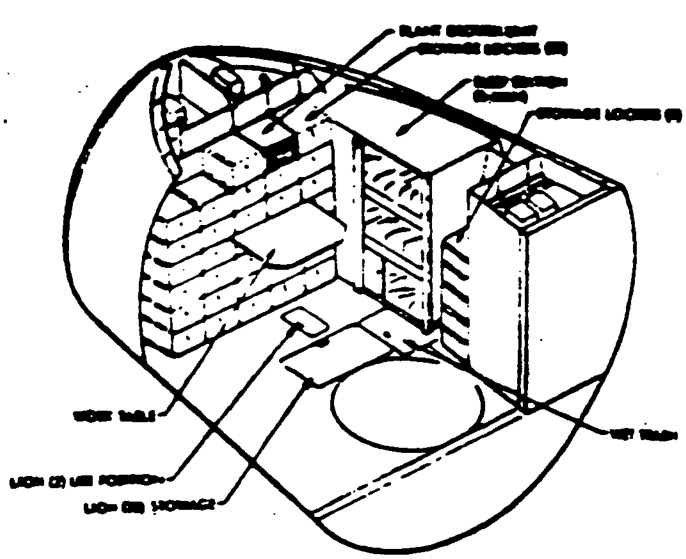


Figure 3.1.5-8(a)   Reference (6)



PGU payload installation in orbiter forward
middeck stowage area

Figure 3.1.5-8(b)   Reference (6)

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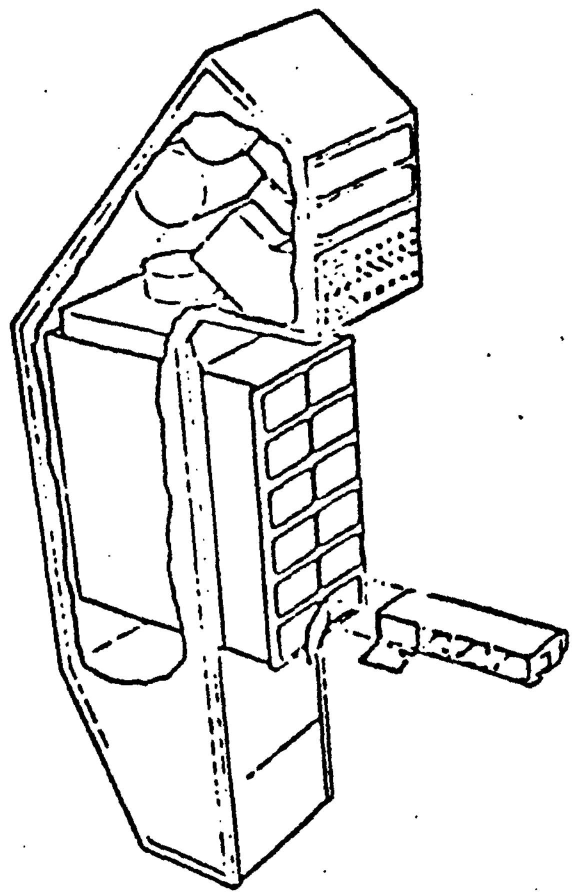

Figure 3.1.5-9 Research Animal Holding Facility Reference (5)

Table 3.1.5-5. Space Available Facility Requirements

Power (Electric): (Maximum configuration)

A.C.	120	Volt Average	1031.5 Watts	Peak	3913.5 Watts
D.C.	28	Volt Average		Peak	

Heat Rejection: Average 1752 Watts Peak 4758.5 Watts

Mass: 45-256 (kg) Low-High Configuration

Volume: 1.859 to 10.87 m^3, Low-High Configuration

Temperature: Range 5 - 60°C Average 25 ± 0.25°C

Atmosphere:
ATM 760 ± 30 mmHg
N 590 ± 30 mmHg
H_2O 13 ± 4 mmHg
CO 0.01 mmHg
O_2 150 ± 20 mmHg
CO_2 3.9 ± 3.7 mmHg
NH_3 0.01 mmHg

Relative Humdiity: 10 - 100 (%)

Air Velocity: 0.001 to 0.25 (m^3/sec)

Lighting: On-Cycle 0 - 100 (%)
Intensity (Ft Cndls) 0 - 400
Frequency (nm) 400 - 800

Noise (dB): 130 dB plants NC 50 animals
Gravity: 10^{-5} 95% of time 10^{-3} 100% of time

Specimen	Size	Volume/Specimen	Qty
a) Small mammals	1.5 - 0.1 kg	0.025 - 0.002 m^3	6-36
b) Plants	10 x 10 x 25 cm	26 cm^3	10-32
c) Microorganisms	Microscopic	21.5 ml	2000/mm^2

Data Management:

Channels: Total 27, Per specimen 0 to 2
Data Form: Analog 70%, Digital 30%
Data Rates: Analog 222 kbps, Digital 9.7 kbps
Video/TV: B&W to storage for burst downlink transmission.

NOTES:

1) Will fit into Space Shuttle payload bay.

2) Will receive power and ECLSS support from host vehicle.

3) Will be transferable to/from Shuttle to Station without loss of ECLSS.

Table 3.1.5-5 (Continued)

4) Will be man accessed and tended.

5) Will be totally isolated from human habitat when containing animals or cell/tissue experiments.

6) May be used as transport/storage mechanism for laboratory equipment.

7) Will be integratable into future dedicated life science and/or CELSS facilities.

8) Will be monitored by Station data management center.

9) Will interchangeably accept holding facilities for animals, plants, microorganism and/or equipment.

10) May be reconfigured for follow-on experiments.

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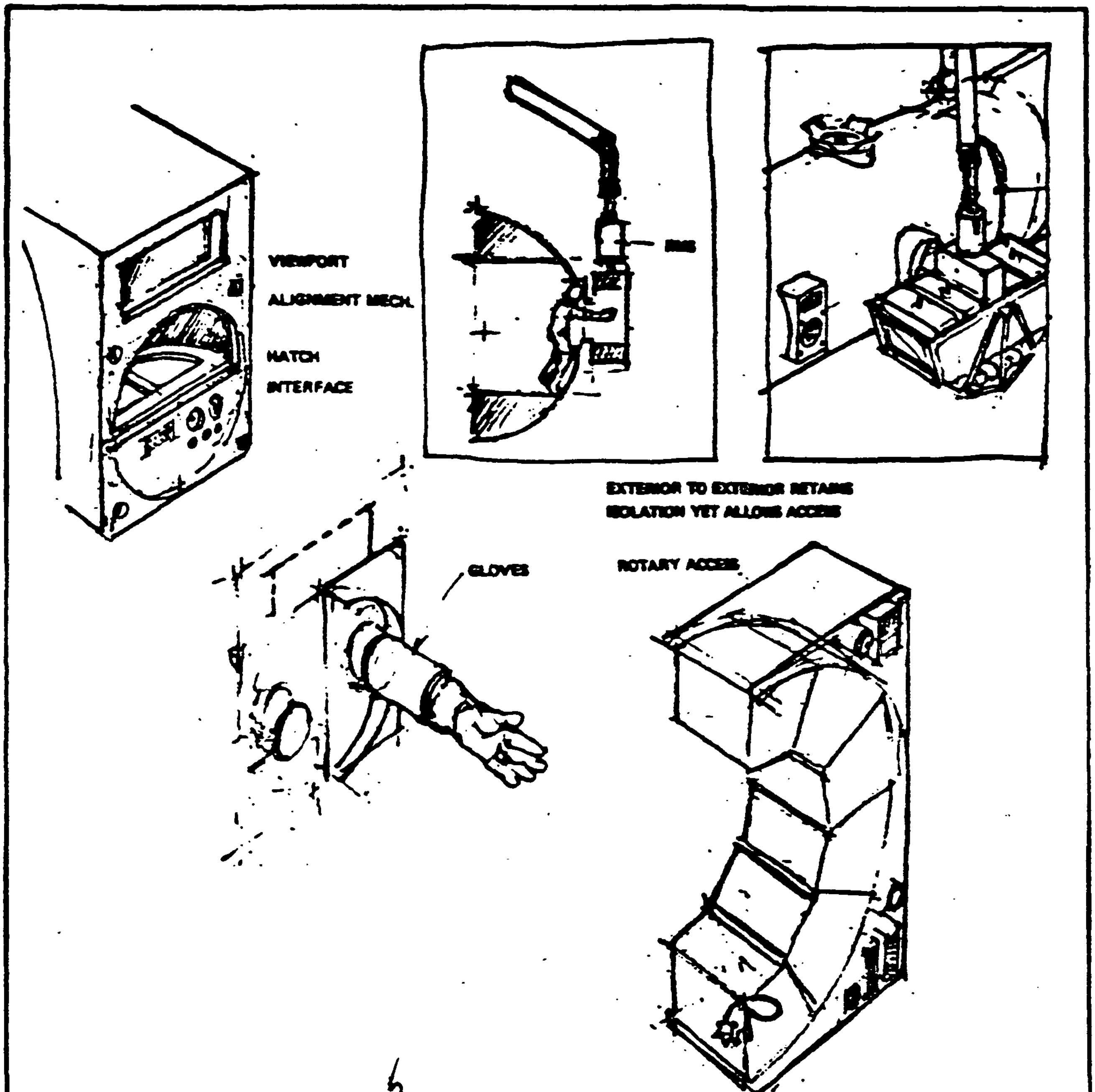

Figure 3.1.5-10(a)   IVA Access for External Pallet

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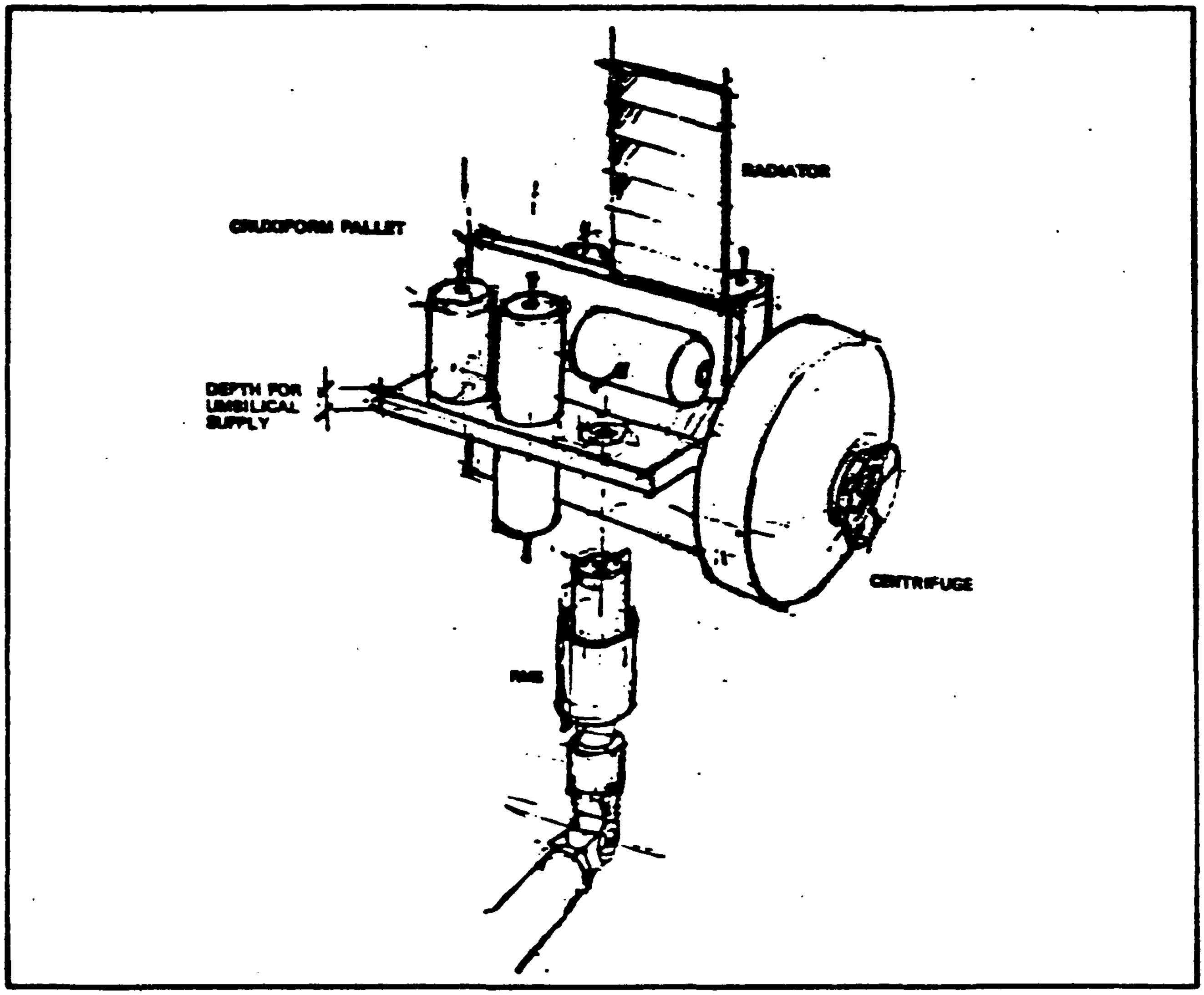

Figure 3.1.5-10(b) Space Station Pallet With Centrifuge

The dedicated Life Science Research laboratory will provide laboratory equipment and facilities for conduct of life science research in areas of zoology, botany, microbiology, and exobiology. The facility will support preliminary experiments in CELSS. To be useful the facility must be large enough for an operator to work inside the pressure vessel. It should have an independent ECLSS designed to handle the varied demands of different life forms. Power will be provided from the Station although auxiliary power units may be incorporated to support emergencies or high draw rates. The lab must be capable of expansion or revision. Modular equipment and convertible specimen holding facilities would be needed. The facility will require a means of contamination/isolation from the main station. The LSRF should be compatible with STS capabilities. Additional desirable features and technical data are provided in Figure 3.1.5-11 and Table 3.1.5-6.

Generation of "Artificial Gravity" is required to conduct experiments in partial g environment and for 1g controls in space. The centrifuge module will be an add-on to the LSRF. This will allow LSRF equipment to support centrifuge based experiments. Power and ECLSS will be drawn from the LSRF. Within the centrifuge, provisions will be made to duplicate the LSRF environment. The centrifuge will be capable of supporting all species being supported in the LSRF. Figure 3.1.5-12 and Table 3.1.5-7 provides an illustration and technical data of a possible centrifuge facility.

Controlled Ecological Life Support System Facility

The CELSS facility is designed to perform three functions. First, continue research on growth physiology of plants and some animals that could support the atmospheric and/or nutritional needs of humans. Second, evaluate the effectiveness of electrical, mechanical and/or chemical devices in regeneration of atmosphere, water and nutritional materials. Third, test the interfaces between plants, animals and non-bionic equipment to develop an effective CELSS. The facility will need to be man accessible. It should have independent ECLSS and electrical power sources. The unit must contain an independent laboratory equipped to the special needs of CELSS research. Ultimately, the CELSS facility will provide partial ECLSS support to the Space Station. Figure 3.1.5-13 is an artist's rendition of a possible CELSS facility. The technical data in Table 3.1.5-8 is based on this unit.

Table 3.1.5-6. Life Science Research Facility

	Length	VOLUME (m^3)	MASS (kg)	POWER (kw)	DATA RATE (kbps)
4.26m	4.	64	3900	11.5	5.4
diameter	8.5	128	6200	21.2	11.9
cylinder	12.	192	7450	28.7	19.7
	17.	256	8300	33.6	29.1

Temperature: Range 5 -60° C Average 25 $\pm$ 0.25°C

Atmospheric Pressure:
ATM 760 $\pm$ 20 mmHg
N_2 590 $\pm$ 30 mmHg
H_2O 13 $\pm$4 4 mmHg
CO 0.01 mmHg
O_2 150 $\pm$ 20 mmHg
CO_2 3.9 $\pm$ 3.7 mmHg
NH_3 0.01 mmHg

Relative Humdity: 10 - 100%

Air Velocity: 0.001 to 0.25 m^3/sec

Lighting:
On-Cycle: 0 - 100%
Intensity (ft Cndls) 0 -400
Frequency (nm) 400 - 800

Noise (dB): 130 dB plants NC 50 animals
Gravity: 10^{-5}g 95% of time; 10^3 100% of time

Specimen	Size	Volume Specimen	Qty
a) Mammals (rat size)	TBD	TBD	0 to 150
b) Vertebrates	TBD	TBD	0 to 288
c) Invertebrates	TBD	TBD	0 to 288
d) Plants	TBD	TBD	0 to 500
e) Microorganisms (colonies)	TBD	TBD	0 to 500

NOTES:

1) Facilities will be provided to prepare, preserve and store specimens for later transport to earth.
2) The LSRF can integrate the space available packages, previously delivered to the Station, into its operations.
3) Provisions will be made for future addition of a 1g centrifuge unit.
4) Independent controllable ECLSS system that can be varied to create microclimate for each test specimen will be installed.
5) Has supplemental power supply to preserve minimal ECLSS requirements in event of Station power failure. Supplemental power could be used during peak loadings.
6) Can safely contain and handle radioisotopes and related support equipment.
7) The pressure vessel will support personnel in a shirtsleeve environment with IVA access to main station.

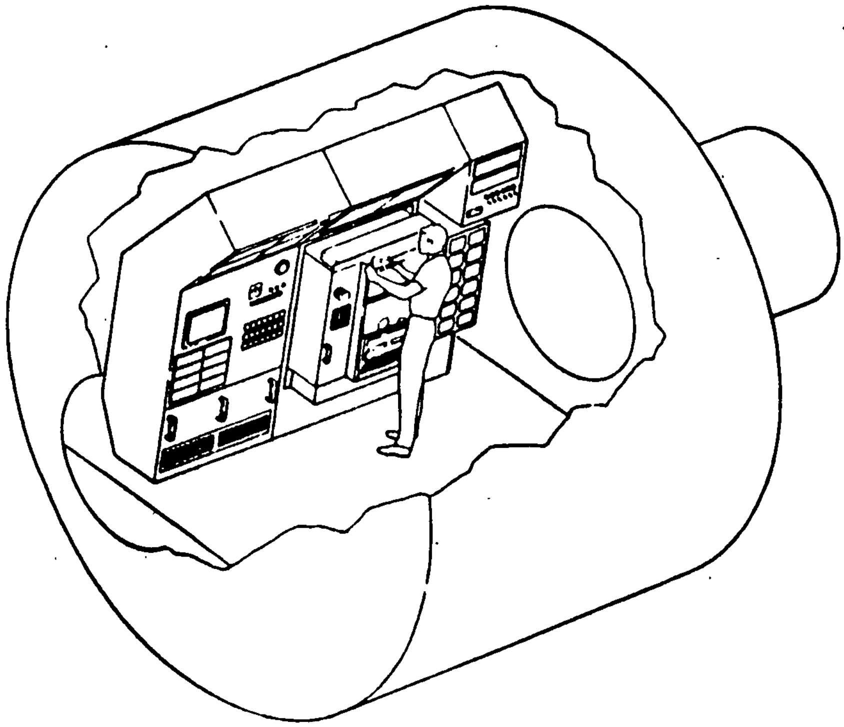

Figure 3.1.5-11(a) Reference (5) Life Sciences Laboratory

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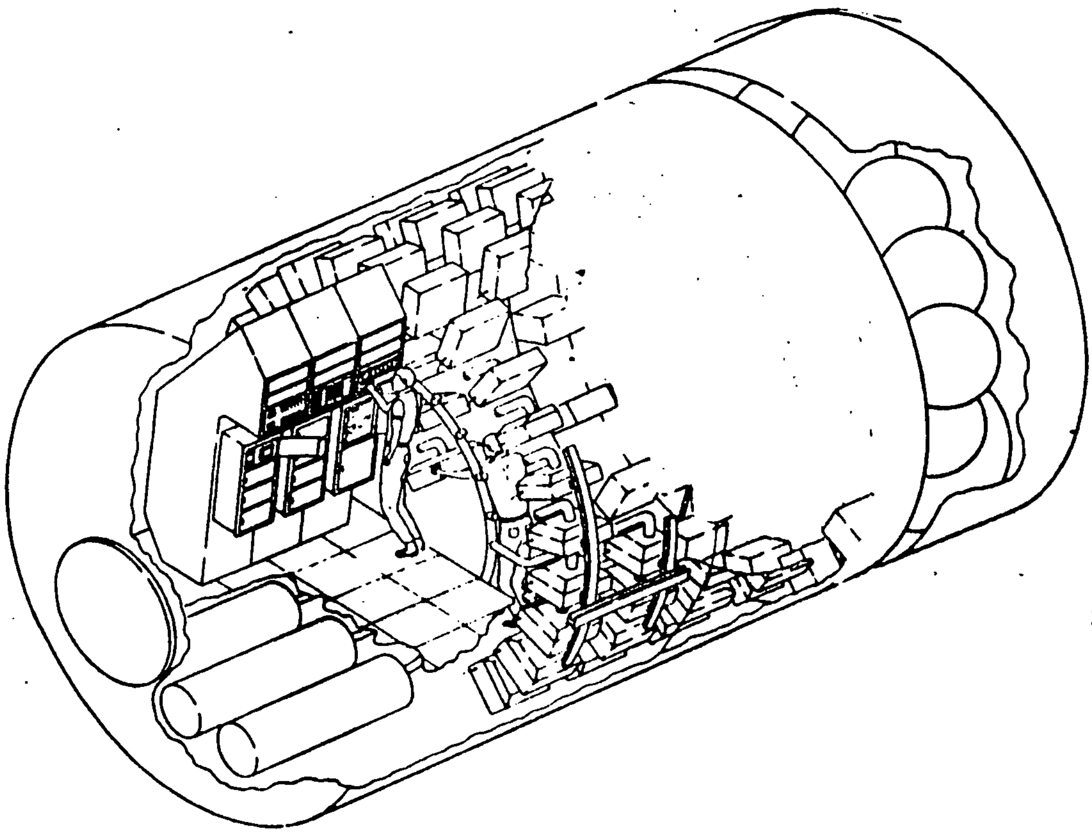

Figure 3.1.5-11(b) Reference (5) Life Sciences Animal Vivarium

Table 3.1.5-7. Centrifuge Facility Requirements

	Length (m)	VOL (m^3)	MASS (kg)	POWER (Watts)	DATA RATE (kbps)
4.26m	1	21.9	287	220	11.5
Diameter	2	43.9	430	415	15
Cylinder	3	65.7	705	680	18
	4	87.6	892	915	27

Temperature:	Range 5-60°C	Average 25 $\pm$ 0.25°C
Atmospheric Pressure:	ATM 760 $\pm$ 20 mmHg N_2 590 $\pm$ 30 mmHg H_2O 13 $\pm$ 4 mmHg CO 0.01 mmHg	O_2 150 $\pm$ 20 mmHg CO_2 3.9 $\pm$ 3.7 mmHg NH_3 0.01 mmHg
Relative Humidity:	10 - 100%	
Air Velocity:	0.001 to 0.25 m^3/sec	
Lighting:	On-Cycle: 0 - 100% Intensity (Ft Cndls) 0 -400 Frequency (nm) 400 -800	
Noise (dB):	130 dB plants	NC 50 animals
Gravity (g):	10^{-5} (95%) not to exceed	10^{-3} during maneuvers

Specimen	Size (kg)	Volume/Specimen (m^3)	Qty
a) Mammal (rat size)	TBD	TBD	0-32
b) Plants	TBD	TBD	0-144
c) Microorganisms (colonies)	TBD	TBD	0-144

Data Management:
Video/TV: 60% video, 40% TV

NOTES:

1) Facility will be designed to attach to the LSRF. Multiple centrifuges may be serially joined.

2) Facility will be shirtsleeve IVA accessible.

3) Centrifuge facility will have adequate internal volume for personnel to perform routine experiment protocols and equipment maintenance.

4) Facility will duplicate holding cages and environment of LSRF.

5) Immediate stop and power loss spin down design provisions will be included in centrifuge design.

6) Independent controllable ECLSS system that can be varied to create a micro climate for each test specimen will be installed.

Table 3.1.5-7 (Continued)

7) Centrifuge will be capable of applying variable g loads to each test specimen. Range of 0.001 to 1g.

8) Centrifuge design will minimize corriolles affects.

9) Centrifuge will maintain some level of gravity 0.1g at perimeter during human interaction for service or experiment operations.

10) Data will be transmitted to LSRF data management system for latter downlink to ground facilities.

11) A real-time and automatic monitoring video system will be availabe for each specimen.

12) Contamination control will be a function of LSRF operation.

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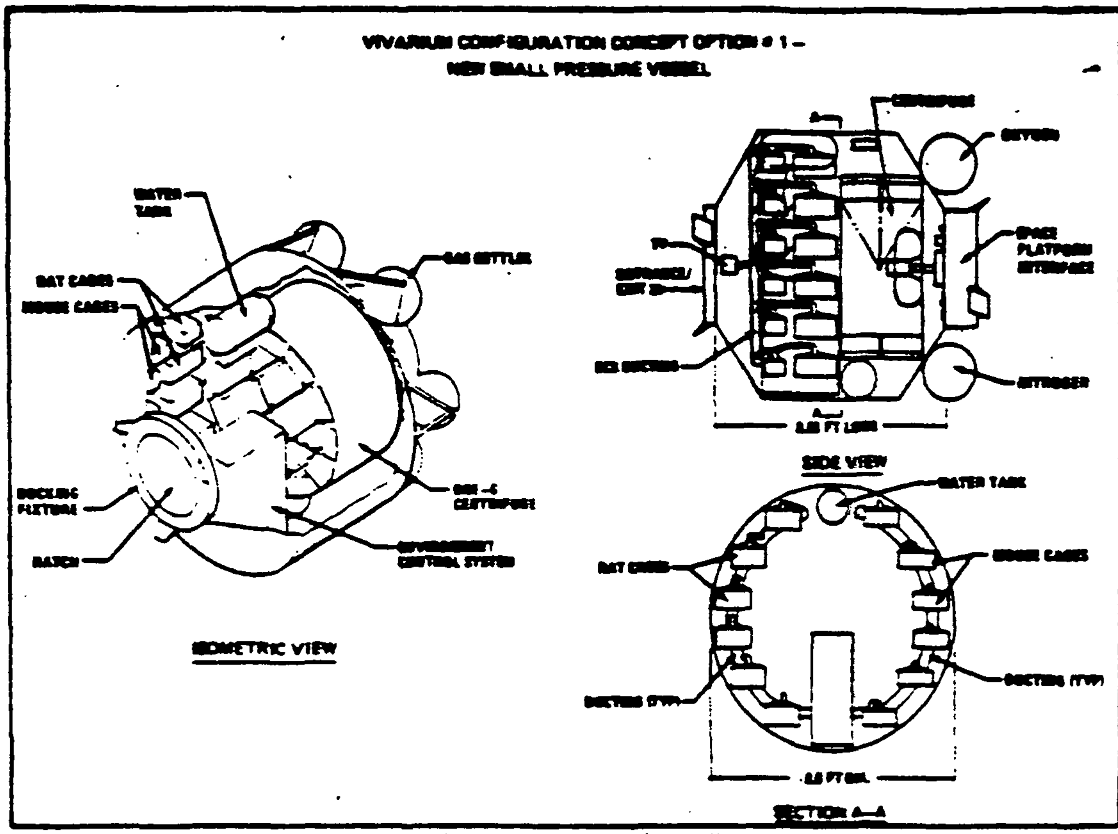

Figure 3.1.5-12(a) Reference (13) Short Module Centrifuge

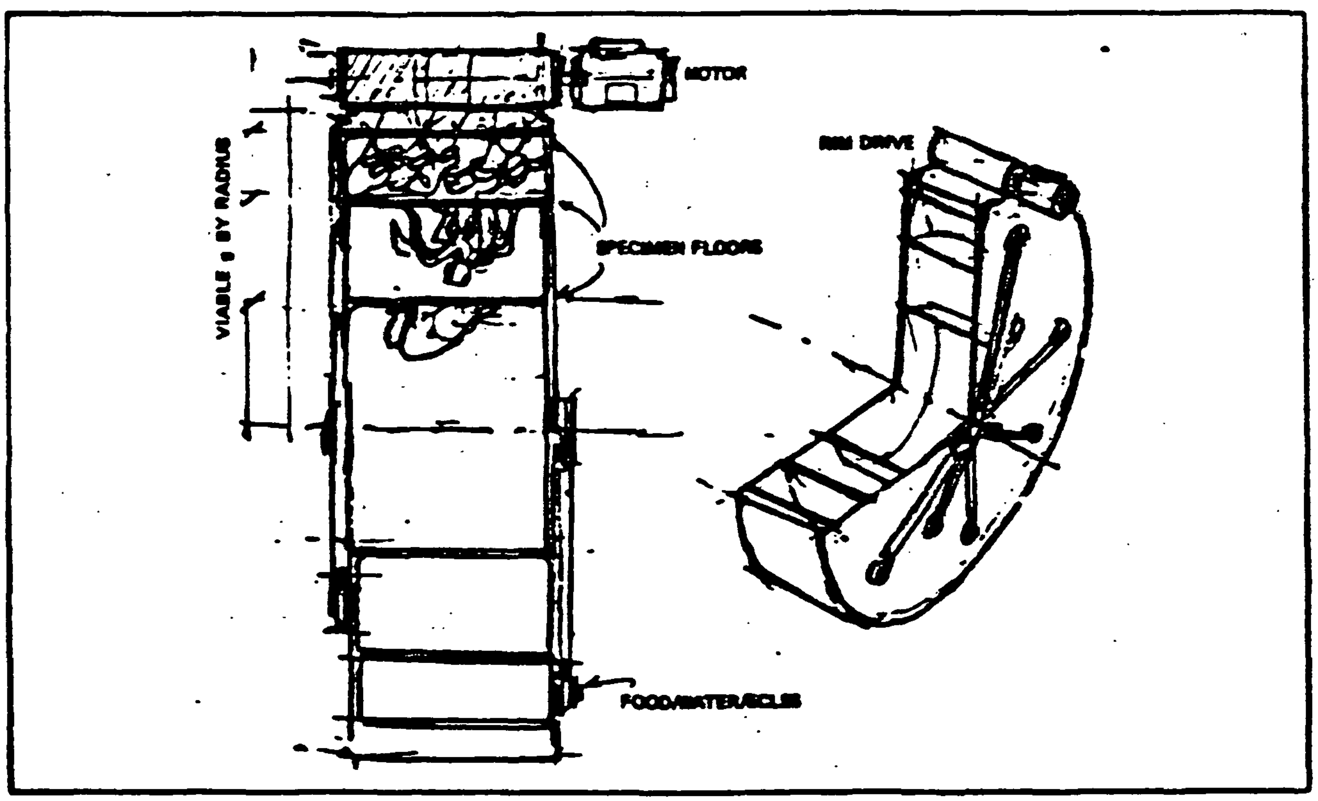

Figure 3.1.5-12(b) Constant-Velocity, Variable-g Centrifuge

Table 3.1.5-8. CELSS Facility Requirements

Power (Electric):

A.C.	28	Volt Average		Peak	
D.C.	120	Volt Average	16.9 K Watts	Peak	23.34 K Watts

Heat Rejection	Average 16.9 K Watts	Peak	23.34 K Watts

Mass:	5691 (kg)		
Dimensions/Volume:	14m (Length)	4.27m (Diameter)	93.90 m^3 (Volume)
Temperature:	Range 20-36°C	Average 24 $\pm$ 1.5°C	
Atmospheric Pressure:	ATM 760 $\pm$ 20 mmHg N_2 590 $\pm$ 30 mmHg H_2O 15 $\pm$ 3 mmHg CO 0.01 mmmHg	O_2 150 $\pm$ 10 mmHg CO_2 3.9 $\pm$ 3.7 mmHg NH_3 0.01 mmHg	
Relative Humidity:	35 to 93% (%), Average 80 $\pm$ 10%		
Air Velocity:	0.01 - 0.1 m^3/sec		
Lighting:	On-Cycle: 0 - 100% Intensity (Ft Cndls) 10-400 Frequency (nm) 400 - 800		
Noise (dB):	130 dB for plants	NC 50 for animals	
Gravity:	10^{-5} 95% of time not to exceed	10^{-3} during maneuvers	
Specimen:	Values for specimen data TBD based on size of LSRF and centrifuge module		

Data Management

Channels:	Total 14, per specimen TBD
Data Form:	Analog 30%, Digital 70%
Data Rates:	Analog 1.7 kbps, Digital 3.9 kbps
Video/TV:	Video 100% monitoring

Contamination Control

1) Not required in facility.
2) Isolation of ECLSS between CELSS facility and habitat module.

NOTES:

1) Laboratory equipment will be tailored to CELSS requirement and may duplicate existing LSRF equipment.

2) CELSS facility will have integral data management unit.

3) Facility will possess independent ECLSS system and emergency/overload source of electrical power sufficient to maintain minimum ECLSS for 90 days.

4) Crew members will be protected from rotating equipment (centrifuge).

Table 3.1.5-8 (Continued)

5) Facility will possess shirtsleeve environment for crew members and will be IVA accessible.

6) Sufficient internal volumn will be allowed for crew to perform experiment and maintenance activities.

7) Facility design will permit safe storage and use of research isotopes.

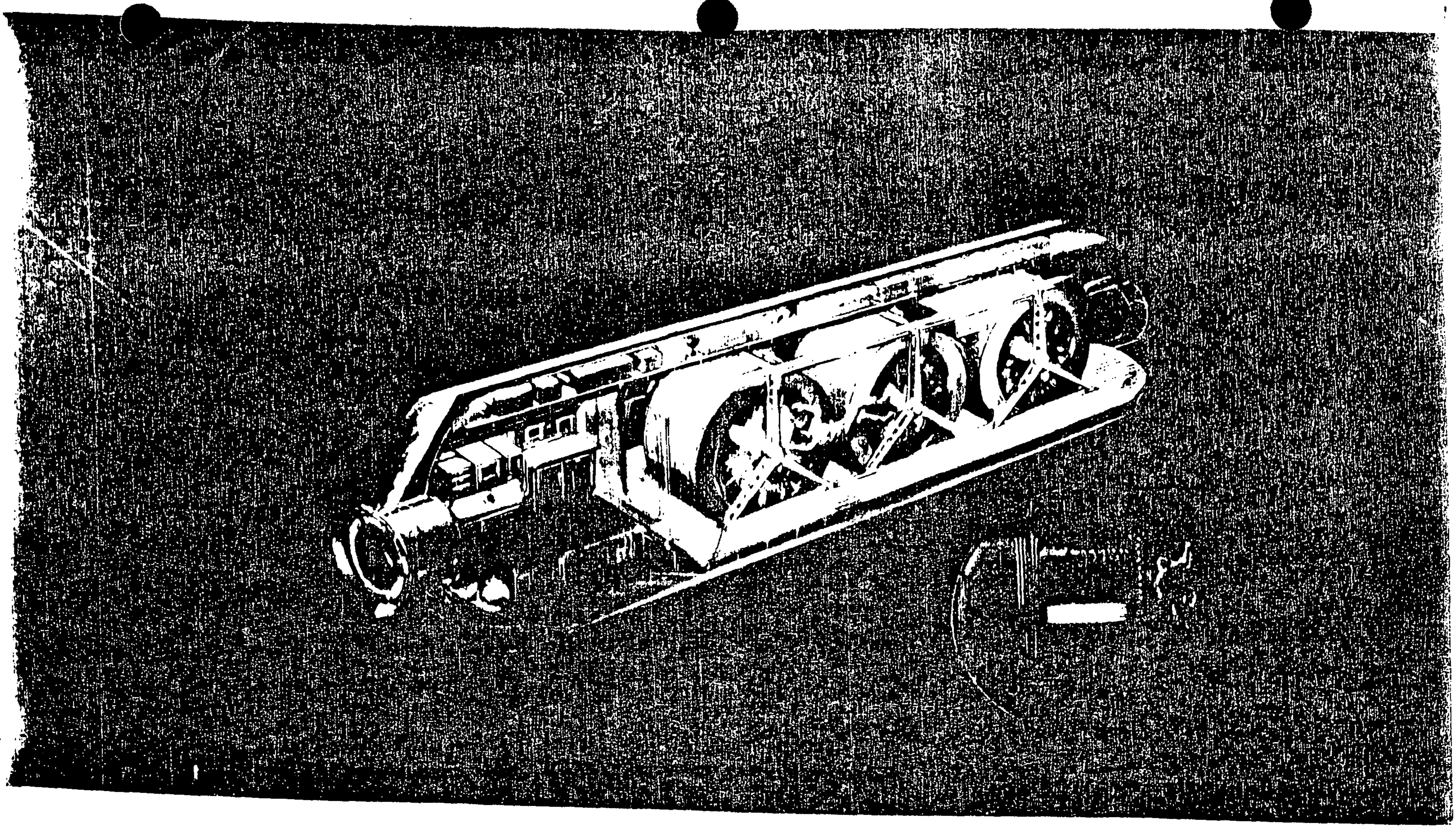

Figure 3.1.5-12(a)

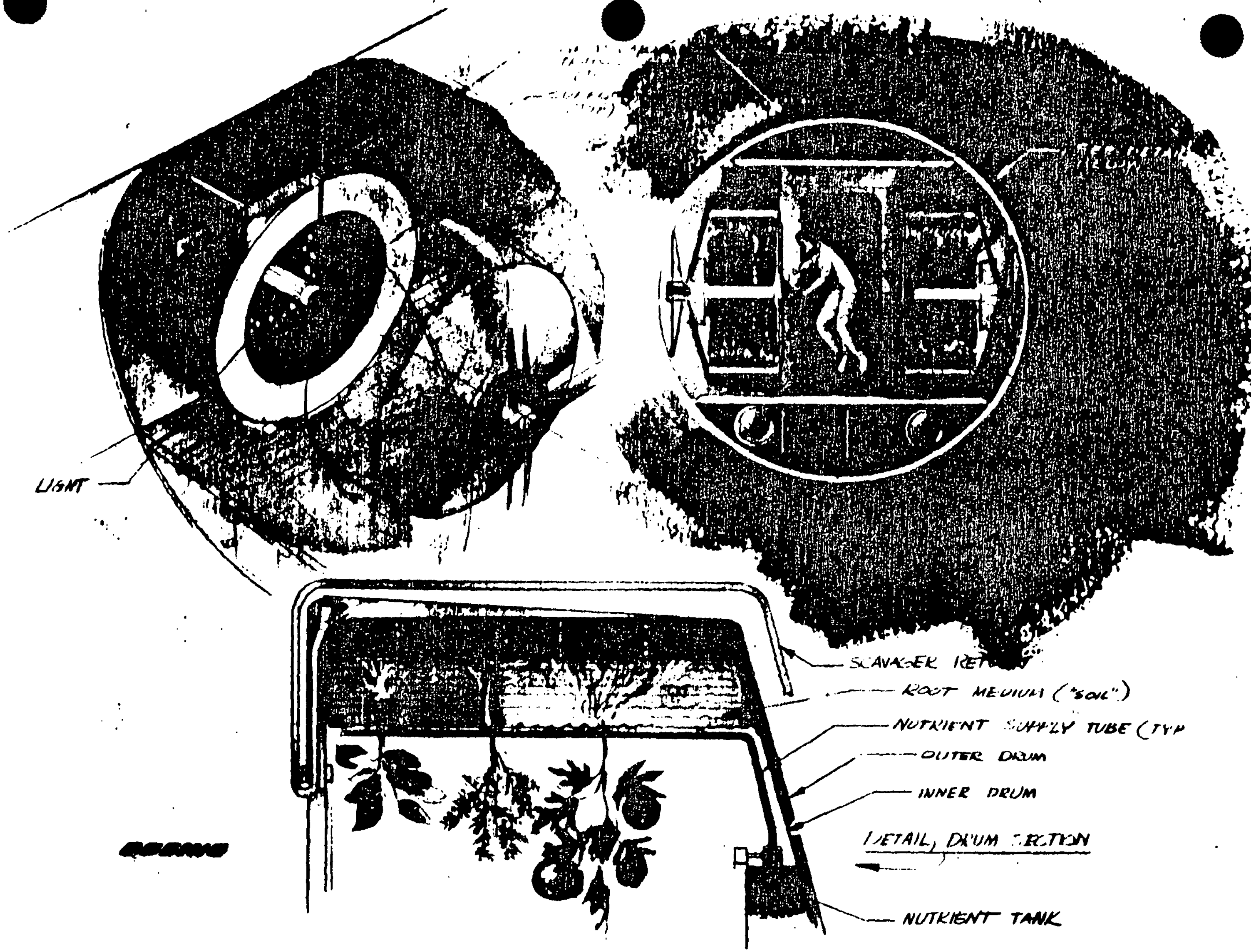

Figure 3.1.5-13(b)

Medical Research Facility

Medical Research Facilities will progress through a "suitcase" stage and a space available stage as the station evolves. When the crew level reaches the 6-8 person level a permanent, operational medical facility will be needed. This facility will possess the capability to support a critically ill/injured crew member long enough to be evacuated. When not in use for operational medicine the facility could function in medical research role.

A variety of designs and requirements are defined in References 2, 7, 11, and 12.

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7.1.5.2 Life Sciences Researchers

November 5, 1982

Dear :

The Boeing Aerospace Company has been charged by NASA with assessing user requirements for a large manned space station.

As we perceive it, NASA's goal is twofold. Primarily they want to establish the technical base for determining design requirements ahead of the actual design effort and, secondly, they want to establish a need by collecting a detailed profile of user activities that require a long duration manned facility.

You have been identified as a potential user in the area of Life Sciences and we would appreciate any assistance you might be able to give us.

I have enclosed some general information about the large space satellite and a copy of a NASA form (in three parts) which they use to identify user requirements. I realize that many advanced concepts have not been engineered to the level where all this information is even estimable; it remains "to be determined." Any information you can provide will be gratefully appreciated.

Perhaps the simplest procedure for reporting this information is by telephone after jotting down a few inputs on the form. I will plan to call you in the near future, or alternately you may contact met at (206) 773-7995. If you wish, however, please feel free to fill in the forms and mail them back to me.

If you are not an appropriate contact for this work perhaps you may be able to suggest someone whom we should contact.
Thank you for your assistance in this endeavor.

Yours sincerely,

Derek Mahaffey
Mail Stop 84-06

Enclosures

SPACE STATION NEEDS, ATTRIBUTES AND OPTIONS

BACKGROUND OF SPACE STATION STUDIES

- The idea of a large, multipurpose satellite in earth orbit has been discussed for a number of years.
- NASA has conducted studies of an unmanned platform and a manned station in recent years. Either of these would be modular, assembled in orbit, and serviced by the Shuttle.
- Now NASA has decided to develop a Manned Space Station to be assembled in low earth orbit with inclinations from equatorial to polar possible. It is hoped that design can begin in 1985, and launch and assembly begin in the 1990's.*
- The Station will generate power, handle relatively large amounts of data for analysis on board or transmission to the ground, and have facilities for extra-vehicular activity.
- To derive the architecture of the Station and determine the range of uses for it, NASA wishes to discuss the program with potential users in the following areas:
  - Scientific investigations in all areas;
  - Applications: remote sensing, etc.
  - Commercial;
  - Technology development;
  - National security;
  - Operations: assembly and injection of geosynchronous or planetary spacecraft; servicing free-flyers, etc.

Identified users may have the opportunity to assist in a continuing basis in defining and developing a station.

---

*A description of this program may be found in Science 217, 1018-1021 (September 10, 1982).

SPACE STATION MISSION ANALYSIS

- NASA has commissioned eight companies to identify potential users of a manned Space Station in low earth orbit and to study the impact of their requirements on Station architecture.

- Boeing Aerospace Corporation is one of the eight companies.

- We plan to discuss the Space Station with key investigators in each relevant technical area.

- We invite you to contribute to our study by providing one or more of the following:

  - Any general comments that you care to make about the future space program and the possible role of a Space Station in it.

  - Names of colleagues and associates who might be interested in talking with us.

  - Descriptions of specific experiments or programs that you would like to carry out that would benefit from or use a Space Station.

- If you have a specific use we need to identify the requirements it would place on a Station. Areas of impact include mass, volume, power, data processing, and crew support.

SPACE STATION MISSION ANALYSIS STUDY

- A form supplied by NASA is attached to summarize requirements of space station missions.

- The first page provides general mission information. Please fill out as completely as possible.

- The second and third pages will allow you to indicate specific mission requirements. Please fill out those sections that may have a significant impact on your experiments.

- In addition, we would like comments on the effectiveness of manned space missions for scientific investigations in your field and specific information on possible crew involvement in your experiments.

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7.1.5.3 Life Sciences User Data Forms

PAYLOAD ELEMENT NAME
HUMAN CARDIO PULMONARY SYSTEM

CODE
BACX0501

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 MS/ 8C/23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 8

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1990 Number of Flights Duration of Flight, Days 90-360

OBJECTIVE
CONDUCT RESEARCH ON THE EFFECTS OF PROLONGED EXPOSURE TO ZERO G ON THE HUMAN CARDIO PULMONARY SYSTEM.

DESCRIPTION
ASTRONAUTS CARDIO PULMONARY SYSTEM WILL BE ROUTINELY MONITORED AS A PART OF GENERAL HEALTH PLAN. AT INTERVALS SPECIAL TESTS WILL BE CONDUCTED TO EVALUATE AFFECTS OF STRESS, HEAT AND MEDICATION.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
(X) AC (X) DC

	Power, W	Duration, Hrs/Day	
Operating	47		
Standby			(X) Continuous
Peak	847	28.00	
Voltage, V	28DC 120AC	Frequency, Hz	60

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times		
OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	.01	man-days/year
EVA Service		man-days/year
Experiment Ops	.11	man-days/year
Service Frequency	4.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

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Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
ASTRONAUTS CARDIO PULMONARY SYSTEM WILL BE ROUTINELY MONITORED AS A PART OF GENERAL HEALTH PLAN. AT INTERVALS SPECIAL TESTS WILL BE CONDUCTED TO EVALUATE AFFECTS OF STRESS, HEAT AND MEDICATION.

Item Dry Weight: 214 pounds　　Volume: 9.16 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 214.00 pounds

Design Complexity:

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	25 %
Digital	25 %
Power Supplies	50 %
Other	%

Manufacturing Complexity for Electronic Items: 5

Weight of the Circuit Board and Electronics Mounted on it: 21.40 pounds

Material Used for the Enclosure: ALUMINUM & STEEL　　Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 90

Of the sturctural weight, what % is off-the-shelf? 80

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
BODY FLUIDS

CODE
BACX0502

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C/23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1990 Number of Flights Duration of Flight, Days 90,180,360

OBJECTIVE
STUDY THE AFFECTS OF LONG TERM ZERO G ON HUMAN BODY FLUIDS.

DESCRIPTION
DURING SPACE STATION OPERATIONS SAMPLES OF HUMAN BODY FLUIDS WILL BE PERIODICALLY COLLECTED AND ANALYZED.
SOME FLUID WILL BE PRESERVED AND RETURNED TO EARTH FOR FURTHER STUDY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km
Perigee, km
Tolerance + -
Inclination, deg
Tolerance + -
Nodal Angle, deg
Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec
Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	131	1.50
Standby		
Peak	696	
Voltage, V	28	

( ) Continuous

Frequency, Hz 60

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum 18 Maximum 32
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum 1907

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 0.50 meters Width: 0.40 meters Height: 0.40 meters (Stowed)
Length: 0.50 meters Width: 0.40 meters Height: 0.40 meters (Deployed)
Launch mass, kg: 6 Return mass, kg: 8
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill	2									
Level	2									
Hours/Day	0.04									

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval 90 days Consumables 44 kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

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Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service		man-days/year
EVA Service		man-days/year
Experiment Ops	.01	man-days/year
Service Frequency	4.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) [illegible] compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
DURING SPACE STATION OPERATIONS SAMPLES OF HUMAN BODY FLUIDS WILL BE PERIODICALLY COLLECTED AND ANALYZED. SOME FLUID WILL BE PRESERVED AND RETURNED TO EARTH FOR FURTHER STUDY.

Item Dry Weight: 519 pounds   Volume: 16.76 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 480.00 pounds

Design Complexity: 6

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:
Analog %
Digital %
Power Supplies %
Other %

Manufacturing Complexity for Electronic Items: 5

Weight of the Circuit Board and Electronics Mounted on it: 39.00 pounds

Material Used for the Enclosure: ALUMINUM/PLASTIC   Machine Casting?

Of the electronics weight, what % is off-the-shelf? 95

Of the sturctural weight, what % is off-the-shelf? 60

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
HUMAN SENSORY SYSTEMS

CODE
BACX0503

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
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Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 6

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1990 Number of Flights Duration of Flight, Days 30,90,180

OBJECTIVE
EVALUATE THE AFFECT OF PROLONGED ZERO G ON THE HUMAN SENSORY SYSTEMS.

DESCRIPTION
DURING SPACE STATION OPERATIONS PERSONNEL WILL BE PERIODICALLY EVALUATED AS TO PERFORMANCE OF SENSORY SYSTEMS. RECORDS WILL BE MAINTAINED OF EPISODIC EVENTS THAT INDICATE A VARIATION FROM SENSORY SYSTEM NORMS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	183	0.50
Standby		
Peak	417	
Voltage, V	28	Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None ( ) Realtime ( ) Offline (X) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

( ) On-Board Data Processing Required

Description:

Data Types: ( ) Analog ( ) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): .5 Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL

(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	18	Maximum	32
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum		Maximum	
	Non-operational Minimum	481	Maximum	898

EQUIPMENT PHYSICAL CHARACTERISTICS

Location (X) Internal ( ) External ( ) Remote

Equipment ID/Function (X) Pressurized ( ) Unpressurized

Length: 0.40 meters Width: 0.60 meters Height: 0.30 meters (Stowed)

Length: meters Width: meters Height: meters (Deployed)

Launch mass, kg: 177 Return mass, kg:

Consumable Types

Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS

Crew Size

Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.40										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90	days	Consumables	kg
	Returnables		kg	Man hours required	
Configuration Changes:	Interval		days	Man-Hours Required	
	Deliverables		kg	Returnables	kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
- (X) Low
- ( ) Medium
- ( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	.001	man-days/year
EVA Service		man-days/year
Experiment Ops	.02	man-days/year
Service Frequency	4.0	times/year

Delta Velocities
- Up
- Down
- Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
- ( ) No Restrictions
- ( ) Only with compatible payloads
- ( ) Fly-Alone
- (X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

ORIGINAL PAGE IS OF POOR QUALITY

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
DURING SPACE STATION OPERATIONS PERSONNEL WILL BE PERIODICALLY EVALUATED AS TO PERFORMANCE OF SENSORY SYSTEMS. RECORDS WILL BE MAINTAINED OF EPISODIC EVENTS THAT INDICATE A VARIATION FROM SENSORY SYSTEM NORMS.

Item Dry Weight: 399 pounds   Volume: 27.00 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 883.00 pounds

Design Complexity:

Manufacturing Complexity for Structural/Mechanical Items: 5
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:
Analog %
Digital %
Power Supplies %
Other %

Manufacturing Complexity for Electronic Items: 5

Weight of the Circuit Board and Electronics Mounted on it: 82.00 pounds

Material Used for the Enclosure: ALUMINUM/PLASTIC   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 90

Of the sturctural weight, what % is off-the-shelf? 70

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
MUSCULOSKELETAL (HUMAN)

CODE
BACX0504

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1991 Number of Flights Duration of Flight, Days

OBJECTIVE
ANALYZE CHANGES IN HUMAN MUSCULOSKELETAL SYSTEM AS A RESULT OF PRO-LONGED EXPOSURE TO ZERO G.

DESCRIPTION
DURING SPACE STATION OPERATIONS THE CREW MEMBER WILL BE MONITORED FOR CHANGES IN HUMAN MUSCULO-SKELETAL SYSTEM.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	313	0.50
Standby		
Peak	313	
Voltage, V	28	Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): 0.50 Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	18	Maximum	32
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum		Maximum	313
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.00 meters Width: 1.80 meters Height: 1.20 meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 134 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.50										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90	days	Consumables	0	kg
	Returnables	0	kg	Man hours required	4	
Configuration Changes:	Interval		days	Man-Hours Required		
	Deliverables		kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	.005	man-days/year
EVA Service		man-days/year
Experiment Ops	4.58	man-days/year
Service Frequency	12	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
DURING SPACE STATION OPERATIONS THE CREW MEMBER WILL BE MONITORED FOR CHANGES IN HUMAN MUSCULO-SKELETAL SYSTEM.

Item Dry Weight: 294 pounds   Volume: cubic feet

Structural Weight (includes typical "mechanical" items listed below): 187.00 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	30	%
Digital	40	%
Power Supplies	30	%
Other		%

Manufacturing Complexity for Electronic Items: 7

Weight of the Circuit Board and Electronics Mounted on it: 35.00 pounds

Material Used for the Enclosure: PLASTIC & ALUMINUM   Machine Casting? Yes

Of the electronics weight, what % is off-the-shelf? 70

Of the sturctural weight, what % is off-the-shelf? 50

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

ORIGINAL PAGE IS OF POOR QUALITY

PAYLOAD ELEMENT NAME
BONE LOSS

CODE
BACX0505

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 8

STATUS
(X) Operational ( ) Approved (X) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1991 Number of Flights 1 Duration of Flight, Days 90,360

OBJECTIVE
STUDY THE EFFECTS OF ZERO G ENVIRONMENT ON BONE GROWTH PHYSIOLOGY IN SMALL MAMMALS

DESCRIPTION
RATS OR SIMILAR TEST SPECIMENS WILL BE SUBJECTED TO ZERO G ENVIRONMENT FOR A PERIOD OF 90 OR 360 DAYS. URINE & FECAL SAMPLES WILL BE COLLECTED FOR ANALYSIS OF CALCIUM LEVELS. ANIMALS WILL BE RETURNED ALIVE TO EARTH FOR EXAMINATION. GROUND CONTROLS WILL BE USED IN LIEU OF INFLIGHT ARTIFICIAL GRAVITY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	585	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	19	Maximum	21
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	110	Maximum	540
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.04 meters Width: 0.57 meters Height: 0.60 meters (Stowed)
Length: 1.04 meters Width: 0.57 meters Height: 0.60 meters (Deployed)
Launch mass, kg: 256 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1 Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.20										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90 days	Consumables	720 kg
	Returnables	16 kg	Man hours required	6.00
Configuration Changes:	Interval	90 days	Man-Hours Required	
	Deliverables	720 kg	Returnables	kg

SPECIAL CONSIDERATIONS/See Instructions
PASSIVE EXPERIMENT THAT CAN BE RUN SIMULTANEOUSLY
WITH OTHER NON INVASIVE - NON STRESS EXPERIMENTS ON SAME SPECIMEN.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	.01	man-days/year
EVA Service		man-days/year
Experiment Ops	.02	man-days/year
Service Frequency	12	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width:	meters	Height: meters	(Stowed)
Length: meters	Width:	meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
RATS OR SIMILAR TEST SPECIMENS WILL BE SUBJECTED TO ZERO G ENVIRONMENT FOR A PERIOD OF 90 OR 360 DAYS. URINE & FECAL SAMPLES WILL BE COLLECTED FOR ANALYSIS OF CALCIUM LEVELS. ANIMALS WILL BE RETURNED ALIVE TO EARTH FOR EXAMINATION. GROUND CONTROLS WILL BE USED IN LIEU OF INFLIGHT ARTIFICIAL GRAVITY.

Item Dry Weight: 564 pounds   Volume: 8.97 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 555.00 pounds

Design Complexity: 6

Manufacturing Complexity for Structural/Mechanical Items: 4
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	10 %
Digital	0 %
Power Supplies	0 %
Other	90 %

Manufacturing Complexity for Electronic Items: 2

Weight of the Circuit Board and Electronics Mounted on it: 1.00 pounds

Material Used for the Enclosure: SHEET ALUMINUM   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 100

Of the sturctural weight, what % is off-the-shelf? 100

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
MUSCLE LOSS

CODE
BACX0506

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 8

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1991 Number of Flights 1 Duration of Flight, Days 90,360

OBJECTIVE
EVALUATE THE EFFECTS OF EXTENDED PERIODS OF ZERO-G ON THE PHYSIOLOGY OF MUSCLE TISSUE IN SMALL MAMMALS IN SUPPORT OF MEDICAL RESEARCH.

DESCRIPTION
RATS OR SIMILAR SPECIMENS WILL BE SUBJECTED TO ZERO-G ENVIRONMENT FOR 90 OR 360 DAYS. FOOD CONSUMPTION AND METABOLISM WILL BE MONITORED. SPECIMENS WILL BE 'WEIGHED' DAILY. AT END OF EXPERIMENT SPECIMENS WILL BE RETURNED TO EARTH FOR EXAMINATION. CONTROLS WILL BE ON EARTH.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	593	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	19	Maximum	22
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	110	Maximum	540
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.04 meters Width: 0.57 meters Height: 0.60 meters (Stowed)
Length: 1.00 meters Width: meters Height: meters (Deployed)
Launch mass, kg: 256 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1

Skills (See Table B)

Task Assignments

Skill	2										
Level	1										
Hours/Day	0.20										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90	days	Consumables	720	kg
	Returnables	16	kg	Man hours required	6.00	
Configuration Changes:	Interval	90	days	Man-Hours Required		
	Deliverables	720	kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions
PASSIVE EXPERIMENTS THAT CAN BE RUN SIMULTANEOUSLY WITH OTHER NON-INVASIVE - NON STRESS EXPERIMENTS ON THE SPECIMEN.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	.01	man-days/year
EVA Service		man-days/year
Experiment Ops	.02	man-days/year
Service Frequency	12	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
RATS OR SIMILAR SPECIMENS WILL BE SUBJECTED TO ZERO-G ENVIRONMENT FOR 90 OR 360 DAYS. FOOD CONSUMPTION AND METABOLISM WILL BE MONITORED. SPECIMENS WILL BE 'WEIGHED' DAILY. AT END OF EXPERIMENT SPECIMENS WILL BE RETURNED TO EARTH FOR EXAMINATION. CONTROLS WILL BE ON EARTH.

Item Dry Weight: 564 pounds   Volume: 8.97 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 555.00 pounds

Design Complexity: 6

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	10 %	
Digital	0 %	
Power Supplies	0 %	
Other	90 %	

Manufacturing Complexity for Electronic Items: 2

Weight of the Circuit Board and Electronics Mounted on it: 1.00 pounds

Material Used for the Enclosure: ALUMINUM   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 100

Of the sturctural weight, what % is off-the-shelf? 100

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
FLUID & ELECTROLYTE

CODE
BACX0507

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
(X) Operational ( ) Approved (X) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1992 Number of Flights 1 Duration of Flight, Days 90,360

OBJECTIVE
EVALUATE THE EFFECTS OF ZERO G ON SMALL MAMMALS FLUID & ELECTROLYTE BALANCE DURING EXTENDED SPACE FLIGHT.

DESCRIPTION
SMALL MAMMALS WILL BE KEPT IN ZERO G ENVIRONMENT FOR 90 OR 360 DAYS. URINE & FECAL MATERIAL WILL BE COLLECTED CONTINUALLY FOR LATER ANALYSIS. SPECIMENS WILL BE RETURNED TO EARTH FOR EXAMINATION.. CONTROL SUBJECTS WILL BE MAINTAINED ON EARTH.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	585	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	19	Maximum	22
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	110	Maximum	540
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.04 meters Width: 0.57 meters Height: 0.60 meters (Stowed)
Length: 1.04 meters Width: 0.57 meters Height: 0.60 meters (Deployed)
Launch mass, kg: 256 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1

Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.20										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90	days	Consumables	720	kg
	Returnables	16	kg	Man hours required	6.00	
Configuration Changes:	Interval	90	days	Man-Hours Required		
	Deliverables	720	kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions
PASSIVE EXPERIMENT THAT CAN BE RUN SIMULTANEOUSLY WITH OTHER NON INVASIVE - NON STRESS EXPERIMENTS ON THE SPECIMEN.

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	.01	man-days/year
EVA Service		man-days/year
Experiment Ops	.02	man-days/year
Service Frequency	12	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

ORIGINAL PAGE IS OF POOR QUALITY

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
SMALL MAMMALS WILL BE KEPT IN ZERO G ENVIRONMENT FOR 90 OR 360 DAYS. URINE & FECAL MATERIAL WILL BE COLLECTED CONTINUALLY FOR LATER ANALYSIS. SPECIMENS WILL BE RETURNED TO EARTH FOR EXAMINATION.. CONTROL SUBJECTS WILL BE MAINTAINED ON EARTH.

Item Dry Weight: 564 pounds   Volume: 8.97 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 555.00 pounds

Design Complexity: 6

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	10 %
Digital	0 %
Power Supplies	0 %
Other	90 %

Manufacturing Complexity for Electronic Items: 2

Weight of the Circuit Board and Electronics Mounted on it: 1.00 pounds

Material Used for the Enclosure: ALUMINUM   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 100

Of the sturctural weight, what % is off-the-shelf? 100

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
NON HUMAN CARDIOVASCULAR

CODE
BACX0508

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 7

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1990 Number of Flights 2 Duration of Flight, Days 90,180,720

OBJECTIVE
MONITOR AND EVALUATE THE EFFECT OF PROLONGED [illegible] SPACEFLIGHT ON THE CARDIOVASCULAR SYSTEM OF SMALL MAMMALS.

DESCRIPTION
SMALL MAMMALS WILL BE SUBJECTED TO PROLONGED PERIODS OF ZERO-G. CARDIAC MONITORING WILL BE CONDUCTED USING INPLANT TELEMETRY DEVICES. SPECIMENS MAY BE PERIODICALLYH SACRIFICED TO STUDY CARDI8OVASCULAR SYSTEM AT INTERMEDIATE STAGES. GROUND CONTROLS WILL BE USED IN LIEU OF INFLIGHT ARTIFICIAL G.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	618	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) 1 Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum 19 Maximum 22
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum 110 Maximum 660
Non-operational Minimum Maximum

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EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.10 meters Width: .60 meters Height: .60 meters (Stowed)
Length: 1.10 meters Width: .60 meters Height: .60 meters (Deployed)
Launch mass, kg: 256 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1

Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.20										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval 90 days Consumables 720 kg
Returnables 16 kg Man hours required 6.00
Configuration Changes: Interval 90 days Man-Hours Required
Deliverables 720 kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions
PROVIDED SPECIMENS ARE NOT ADVERSELY AFFECTED BY INPLANTS THIS EXPERIMENT CAN BE RUN SIMULTANEOUSLY WITH OTHER NON INVASIVE-NON STRESS EXPERIMENTS ON THE SAME SPECIMEN.

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	0.1	man-days/year
EVA Service		man-days/year
Experiment Ops	11.5	man-days/year
Service Frequency	12	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

ORIGINAL PAGE IS OF POOR QUALITY

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
SMALL MAMMALS WILL BE SUBJECTED TO PROLONGED PERIODS OF ZERO-G. CARDIAC MONITORING WILL BE CONDUCTED USING INPLANT TELEMETRY DEVICES. SPECIMENS MAY BE PERIODICALLYH SACRIFICED TO STUDY CARDI8OVASCULAR SYSTEM AT INTERMEDIATE STAGES. GROUND CONTROLS WILL BE USED IN LIEU OF INFLIGHT ARTIFICIAL G.

Item Dry Weight: 566 pounds Volume: 8.97 cubic feet

STRUCTURAL Weight (includes typical "mechanical" items listed below): 580 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	0	%
Digital	30	%
Power Supplies	20	%
Other	50	%

Manufacturing Complexity for Electronic Items: 7

Weight of the Circuit Board and Electronics Mounted on it: 14.00 pounds

Material Used for the Enclosure: ALUMINUM Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 80

Of the sturctural weight, what % is off-the-shelf? 100

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
NON HUMAN MAMMALIAN METABOLISM

CODE
BACX0509

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 9

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1991 Number of Flights 2 Duration of Flight, Days 90,270,730

OBJECTIVE
STUDY THE AFFECTS OF PROLONGED ZERO G ENVIRONMENT ON THE METABOLISM OF A SMALL MAMMAL.

DESCRIPTION
A SMALL MAMMAL WILL BE EXPOSED TO EXTENDED PERIODS OF ZERO G. THE URINE AND FECAL MATTER WILL BE COLLECTED FOR LATER ANALYSIS. RESPIRED AIR WILL BE SAMPLED DAILY AND ANALYZED BY ONBOARD EQUIPMENT. ANIMAL MAY BE RETURNED TO EARTH FOR READAPTION STUDIES.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
(X) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	924	
Voltage, V	28 DC 120 AC	Frequency, Hz 400

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	19	Maximum	22
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	110	Maximum	732
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.70 meters Width: 0.90 meters Height: 0.90 meters (Stowed)
Length: 1.70 meters Width: 0.80 meters Height: 0.90 meters (Deployed)
Launch mass, kg: 291 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1 Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.20										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90 days	Consumables	720 kg
	Returnables	16 kg	Man hours required	6.00
Configuration Changes:	Interval	90 days	Man-Hours Required	
	Deliverables	720 kg	Returnables	kg

SPECIAL CONSIDERATIONS/See Instructions
PASSIVE EXPERIMENT THAT CAN BE RUN SIMULTANEOUSLY WITH NON INVASIVE-NON STRESS EXPERIMENTS ON SAME SPECIMEN.
730 DAY EXPERIMENT WILL REQUIRE SPECIES WITH 90% LIFE EXPECTANCY IN EXCESS OF 730 DAYS.

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	0.1	man-days/year
EVA Service		man-days/year
Experiment Ops		man-days/year
Service Frequency	12.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

ORIGINAL PAGE IS
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Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
A SMALL MAMMAL WILL BE EXPOSED TO EXTENDED PERIODS OF ZERO G. THE URINE AND FECAL MATTER WILL BE COLLECTED FOR LATER ANALYSIS. RESPIRED AIR WILL BE SAMPLED DAILY AND ANALYZED BY ONBOARD EQUIPMENT. ANIMAL MAY BE RETURNED TO EARTH FOR READAPTION STUDIES.

Item Dry Weight: 665 pounds   Volume: 11.60 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 652.00 pounds

Design Complexity: 8

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	10 %
Digital	40 %
Power Supplies	30 %
Other	20 %

Manufacturing Complexity for Electronic Items: 6

Weight of the Circuit Board and Electronics Mounted on it: 34.00 pounds

Material Used for the Enclosure: ALUMINUM PLASTIC   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 40

Of the sturctural weight, what % is off-the-shelf? 85

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
VESTIBULAR PHYSIO IN SM MAMMALS

CODE
BACX0510

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 8

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1990 Number of Flights 3 Duration of Flight, Days 90,180,730

OBJECTIVE
IDENTIFY THE CHANGES IN VESTIBULAR PHYSIOLOGY THAT RESULTS FROM EXTENDED PERIODS IN ZERO G ENVIRONMENT.

DESCRIPTION
SMALL MAMMALS WILL BE SUBJECTED TO EXTENDED PERIODS OF ZERO G. PERIODICALLY A SPECIMEN WILL BE SACRIFICED AND PRESERVED FOR LATER TRANSPORT TO EARTH FACILITIES. SURVIVING SPECIMENS WILL BE RETURNED TO EARTH FOR READAPTION EVALUATION.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	585	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	19	Maximum	22
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	110	Maximum	540
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.10 meters Width: 0.60 meters Height: 0.60 meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 265 Return mass, kg: 12
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1

Task Assignments

Skills (See Table B)

Skill	2									
Level	2									
Hours/Day	0.30									

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90	days	Consumables	1440	kg
	Returnables	32	kg	Man hours required	12.00	
Configuration Changes:	Interval	90	days	Man-Hours Required		
	Deliverables	1472	kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions
LN2 FREEZER REQUIRED FOR SACRIFICED SPECIMENS.

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer
( ) Not Serviced — F
( ) Remote TMS — FT
( ) Remote Manned — FM
( ) Serviced at Station (TMS Retrieved) — FST
( ) Serviced at Station (Self-propelled) — FS

Platform Based
( ) Not Serviced — P
( ) Remote TMS — PT
( ) Remote Manned — PM
( ) Serviced at Station (TMS Retrieved) — PST
( ) Serviced at Station (Self-propelled) — PS

Other
(X) Space Station Based — SS
( ) Sortie — SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	4	man-days/year
EVA Service		man-days/year
Experiment Ops	8.0	man-days/year
Service Frequency	12.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
SMALL MAMMALS WILL BE SUBJECTED TO EXTENDED PERIODS OF ZERO G. PERIODICALLY A SPECIMEN WILL BE SACRIFICED AND PRESERVED FOR LATER TRANSPORT TO EARTH FACILITIES. SURVIVING SPECIMENS WILL BE RETURNED TO EARTH FOR READAPTION EVALUATION.

Item Dry Weight: 846 pounds   Volume: 13.45 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 822.00 pounds

Design Complexity: 6

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	0	%
Digital	10	%
Power Supplies	0	%
Other	90	%

Manufacturing Complexity for Electronic Items: 3

Weight of the Circuit Board and Electronics Mounted on it: 2.00 pounds

Material Used for the Enclosure: ALUMINUM & PLASTIC   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 100

Of the sturctural weight, what % is off-the-shelf? 100

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
VESTIBULAR FUNCTION IN SM MAMMAL

CODE
BACX0511

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 6

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1994 Number of Flights 4 Duration of Flight, Days 90

OBJECTIVE
DETERMINE THE EFFECTS OF PROLONGED ZERO G ON SMALL MAMMALS VESTIBULAR FUNCTION AND EFFECTIVENESS OF SELECTED MEDICATIONS TO CONTROL ADVERSE AFFECTS.

DESCRIPTION
SMALL MAMMALS WILL BE EXPOSED TO PROLONGED PERIODS OF ZERO G. THEIR DAILY ACTIVITY WILL BE MONITORED. THEY WILL BE TESTED FOR RESPONSE TO DIRECTIONAL STIMULI OF PHYSICAL AND VISUAL NATURE. ALL SPECIMENS WILL BE RETURNED TO EARTH FOR READAPTATION EVALUATION. SELECTED SPECIMENS MAY RECEIVE MEDICATION IN THEIR WATER/FOOD TO TEST ITS EFFECTIVENESS AND POSSIBLE LONG TERM HAZARDS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	603	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): 0.00 Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

ORIGINAL PAGE IS OF POOR QUALITY

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum 19 Maximum 22
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum 110 Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: 1.04 meters Width: .6 meters Height: .6 meters (Stowed)
Length: 1.04 meters Width: .6 meters Height: .6 meters (Deployed)
Launch mass, kg: 262 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size Task Assignments

Skills (See Table B)

Skill										
Level										
Hours/Day										

EVA ( ) Yes ( ) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval days Consumables kg
Returnables kg Man hours required
Configuration Changes: Interval days Man-Hours Required
Deliverables kg Returnables kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
(X) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	0.1	man-days/year
EVA Service		man-days/year
Experiment Ops	9.1	man-days/year
Service Frequency	182.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

ORIGINAL PAGE IS
OF POOR QUALITY

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
SMALL MAMMALS WILL BE EXPOSED TO PROLONGED PERIODS OF ZERO G. THEIR DAILY ACTIVITY WILL BE MONITORED. THEY WILL BE TESTED FOR RESPONSE TO DIRECTIONAL STIMULI OF PHYSICAL AND VISUAL NATURE. ALL SPECIMENS WILL BE RETURNED TO EARTH FOR READAPTATION EVALUATION. SELECTED SPECIMENS MAY RECEIVE MEDICATION IN THEIR WATER/FOOD TO TEST ITS EFFECTIVENESS AND POSSIBLE LONG TERM HAZARDS.

Item Dry Weight: 564 pounds   Volume: 8.97 cubic feet

Structural Weight (includes typical "mechanical" items listed below): pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	30 %
Digital	0 %
Power Supplies	30 %
Other	40 %

Manufacturing Complexity for Electronic Items: 4

Weight of the Circuit Board and Electronics Mounted on it: 6.34 pounds

Material Used for the Enclosure: ALUM & PLASTIC   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 100

Of the sturctural weight, what % is off-the-shelf? 100

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
RADIATION BIOLOGY IN SM MAMMALS

CODE
BACX0512

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 6

STATUS
(X) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1997 Number of Flights 1 Duration of Flight, Days 180

OBJECTIVE
OBSERVE & EVALUATE THE AFFECTS OF RADIATION ON SMALL MAMMALS IN PROLONGED ZERO G.

DESCRIPTION
LARGE POPULATION (100) WILL BE SUBJECTED TO SELECTED RADIATION LEVELS WHILE IN A ZERO-G ENVIRONMENT. IF STATION IS IN LEO A RADIATION SOURCE WILL BE REQUIRED. HIGH INCLINATION/ATITUDE ORBIT WILL REQUIRE SHEILDING. ALL SPECIMENS WILL BE RETURNED TO EARTH FOR EXAMINATION.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km 500 Perigee, km Tolerance + -
Inclination, deg 90.0 Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	265	
Standby		(X) Continuous
Peak	585	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function ( ) Pressurized ( ) Unpressurized
Length: 1.04 meters Width: 0.60 meters Height: 0.57 meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 268 Return mass, kg: 12
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size
Task Assignments

Skills (See Table B)

Skill	2										
Level	2										
Hours/Day	0.50										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval 90 days Consumables 36 kg
Returnables 48 kg Man hours required 2.00
Configuration Changes: Interval 90 days Man-Hours Required 16.00
Deliverables 48 kg Returnables 40 kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	4.0	man-days/year
EVA Service		man-days/year
Experiment Ops	0.1	man-days/year
Service Frequency		times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
LARGE POPULATION (100) WILL BE SUBJECTED TO SELECTED RADIATION LEVELS WHILE IN A ZERO-G ENVIRONMENT. IF STATION IS IN LEO A RADIATION SOURCE WILL BE REQUIRED. HIGH INCLINATION/ATITUDE ORBIT WILL REQUIRE SHEILDING. ALL SPECIMENS WILL BE RETURNED TO EARTH FOR EXAMINATION.

Item Dry Weight: 578 pounds Volume: 9.33 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 570.00 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	30 %
Digital	20 %
Power Supplies	50 %
Other	%

Manufacturing Complexity for Electronic Items: 5

Weight of the Circuit Board and Electronics Mounted on it: 1.00 pounds

Material Used for the Enclosure: PLASTIC, ALUM & LEAD Machine Casting? Yes

Of the electronics weight, what % is off-the-shelf? 90

Of the sturctural weight, what % is off-the-shelf? 60

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
ANIMAL DEVELOPMENT

CODE
BACX0513

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 4

STATUS
(X) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1997 Number of Flights 1 Duration of Flight, Days

OBJECTIVE
STUDY THE GROWTH AND DEVELOPMENT OF ANIMALS IN A WEIGHTLESS ENVIRONMENT.

DESCRIPTION
PREGNANT FEMALE SMALL MAMMAL, FERTILIZED CHICKEN EGGS, FERTILIZED FROG EGGS, ECT WILL BE SUBJECTED TO PROLONGED ZERO-G ENVIRONMENT. AT REGULAR INTERVALS SELECTED SPECIMENS WILL BE SACRIFICED AND PRESERVED. AT END OF EXPERIMENT PERIOD SURVIVING SPECIMENS WILL BE RETURNED TO EARTH FOR FURTHER STUDY. CONTROL SPECIMENS WILL BE IN CENTRIFUGE.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
(X) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	415	
Standby		(X) Continuous
Peak	625	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, W Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 4.26 meters Width: 4.26 meters Height: 4.26 meters (Stowed)
Length: 4.26 meters Width: 4.26 meters Height: 4.26 meters (Deployed)
Launch mass, kg: 430 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size 1

Skills (See Table B)

Task Assignments

Skill	2										
Level	1										
Hours/Day	1.50										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval 2 days Consumables 748 kg
Returnables 56 kg Man hours required 60
Configuration Changes: Interval 90 days Man-Hours Required
Deliverables 470 kg Returnables 470 kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	40.0	man-days/year
EVA Service		man-days/year
Experiment Ops	91.3	man-days/year
Service Frequency	180	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

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Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
PREGNANT FEMALE SMALL MAMMAL, FERTILIZED CHICKEN EGGS, FERTILIZED FROG EGGS, ECT WILL BE SUBJECTED TO PROLONGED ZERO-G ENVIRONMENT. AT REGULAR INTERVALS SELECTED SPECIMENS WILL BE SACRIFICED AND PRESERVED. AT END OF EXPERIMENT PERIOD SURVIVING SPECIMENS WILL BE RETURNED TO EARTH FOR FURTHER STUDY. CONTROL SPECIMENS WILL BE IN CENTRIFUGE, IF AVAILABLE, OR IN GROUND FACILITIES.

Item Dry Weight: 789 pounds   Volume: 1006.8 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 717.9 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	35 %
Digital	20 %
Power Supplies	35 %
Other	10 %

Manufacturing Complexity for Electronic Items: 5

Weight of the Circuit Board and Electronics Mounted on it: 72.00 pounds

Material Used for the Enclosure: ALUM, ACRYLIC   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 30

Of the sturctural weight, what % is off-the-shelf? 15

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
ANIMAL REPROD IN SM MAMMALS

CODE
BACX0514

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 6

STATUS
( ) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1995 Number of Flights 1 Duration of Flight, Days 2920

OBJECTIVE
STUDY THE REPRODUCTION OF A SMALL MAMMAL IN EXTENDED EXPOSURE TO A ZERO G ENVIRONMENT.

DESCRIPTION
SMALL MAMMALS WILL BE MATED IN SPACE. THE DEVELOPMENT OF EMBRYOS WILL BE MONITORED. NEWBORNS WILL BE STUDIED FOR GROWTH PATTERNS. MULTIPLE GENERATIONS WILL BE MATED WHILE IN ZERO-G. AT END OF EXPERIMENT, SURVIVING SPECIMENS WILL BE RETURNED TO EARTH. THROUGHOUT PROCESS SELECTED SPECIMENS WILL BE SACRIFICED AND PRESERVED.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	8.5	
Standby		(X) Continuous
Peak	11.5	
Voltage, V	28	Frequency, Hz

```
DATA/COMMUNICATIONS
    Monitoring Requirements:
    ( ) None        ( ) Realtime    ( ) Offline    ( ) Other:
    ( ) Encription/Decription Required
    ( ) Uplink Required:      Command Rate (KBS):          Frequency (MHz):
    ( ) On-Board Data Processing Required
        Description:
        Data Types:   ( ) Analog     ( ) Digital           Hours/Day
        Film (Amount):                                     Voice (Hours/Day):
        Live TV (Hours/Day):                               Other:
        On-Board Storage (Mbit):
        Data Dump Frequency (Per Orbit)                    Downlink command rate:
        Recording Rate (KBPS)                              Downlink Frequency (MHz):
THERMAL
    (X) Active      ( ) Passive
        Temperature, deg C   Operational Minimum         19        Maximum      22
                             Non-operational Minimum               Maximum
        Heat Rejection, W    Operational Minimum        210        Maximum     750
                             Non-operational Minimum               Maximum
EQUIPMENT PHYSICAL CHARACTERISTICS
    Location           (X) Internal          ( ) External      ( ) Remote
    Equipment ID/Function                    (X) Pressurized   ( ) Unpressurized
                   Length:    4.26   meters    Width:        meters      Height:    4.26
                   Length:    4.26   meters    Width:        meters      Height:     4.26  meters     (Deployed)
                   Launch mass, kg:     3900              Return mass, kg:     15
                   Consumable Types  FOOD
                   Acceleration Sensitivity, (g)      min:               max:
CREW REQUIREMENTS
    Crew Size       1          Task Assignments
```

Skill	2										
Level	3										
Hours/Day	14										

```
    Skills (See Table B)

    EVA  ( ) Yes   (X) No          Reason                        Hours/EVA
SERVICING/MAINTENANCE
    Service:                   Interval              1   days   Consumables            4490 kg
                               Returnables         156   kg     Man hours required   225.00
    Configuration Changes:     Interval             30   days   Man-Hours Required   12
                               Deliverables       1439   kg     Returnables      1439        kg
SPECIAL CONSIDERATIONS/See Instructions
```

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	24	man-days/year
EVA Service		man-days/year
Experiment Ops	182	man-days/year
Service Frequency	12	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON

DESCRIPTION
SMALL MAMMALS WILL BE MATED IN SPACE. THE DEVELOPMENT OF EMBRYOS WILL BE MONITORED. NEWBORNS WILL BE STUDIED FOR GROWTH PATTERNS. MULTIPLE GENERATIONS WILL BE MATED WHILE IN ZERO-G. AT END OF EXPERIMENT, SURVIVING SPECIMENS WILL BE RETURNED TO EARTH. THROUGHOUT PROCESS SELECTED SPECIMENS WILL BE SACRIFICED AND PRESERVED.

Item Dry Weight: 8598 pounds   Volume: 2264 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 5158.80 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

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Electronic Equipment Description:

Analog	40	%
Digital		%
Power Supplies	30	%
Other	30	%

Manufacturing Complexity for Electronic Items: 6

Weight of the Circuit Board and Electronics Mounted on it: 515.80 pounds

Material Used for the Enclosure: ALUM & PLASTIC   Machine Casting?

Of the electronics weight, what % is off-the-shelf? 60

Of the sturctural weight, what % is off-the-shelf? 70

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
PLANT PHYSIOLOGY

CODE
BACX0515

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 9

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: 1991 Number of Flights 2 Duration of Flight, Days 90

OBJECTIVE
STUDY THE EFFECTS OF PROLONGED ZERO-G EXPOSURE ON PLANT PHYSIOLOGY.

DESCRIPTION
SEVERAL SPECIES OF VASCULAR PLANTS WILL BE SUBJECTED TO PROLONGED PERIODS OF ZERO-G. THE GROWTH WILL BE MONITORED AND SAMPLES WILL BE SACRIFICED. ALL SURVIVING AND SACRIFICED SPECIMENS WILL BE RETURNED TO EARTH FOR STUDY. CONTROLS WILL BE GROWN ON EARTH UNTIL A SPACE BASED LG CENTRIFUGE IS AVAILABLE.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	195	
Standby		(X) Continuous
Peak	275	
Voltage, V	28	Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	20	Maximum	40
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	195	Maximum	275
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.10 meters Width: 0.50 meters Height: 0.80 meters (Stowed)
Length: 1.10 meters Width: 0.50 meters Height: 0.80 meters (Deployed)
Launch mass, kg: 70 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size
Task Assignments
Skills (See Table B)

Skill	2									
Level	1									
Hours/Day	0.10									

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	30	days	Consumables	12 kg
	Returnables		kg	Man hours required	
Configuration Changes:	Interval	90	days	Man-Hours Required	4
	Deliverables		kg	Returnables	kg

SPECIAL CONSIDERATIONS/See Instructions

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	11.5	man-days/year
EVA Service		man-days/year
Experiment Ops		man-days/year
Service Frequency	24.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length: meters	Width: meters	Height: meters	(Stowed)
Length: meters	Width: meters	Height: meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to [illegible] the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
SEVERAL SPECIES OF VASCULAR PLANTS WILL BE SUBJECTED TO PROLONGED PERIODS OF ZERO-G. THE GROWTH WILL BE MONITORED AND SAMPLES WILL BE SACRIFICED. ALL SURVIVING AND SACRIFICED SPECIMENS WILL BE RETURNED TO EARTH FOR STUDY. CONTROLS WILL BE GROWN ON EARTH UNTIL A SPACE BASED LG CENTRIFUGE IS AVAILABLE.

Item Dry Weight: 154 pounds   Volume: 53.00 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 150.00 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	30 %
Digital	%
Power Supplies	60 %
Other	10 %

Manufacturing Complexity for Electronic Items: 4

Weight of the Circuit Board and Electronics Mounted on it: 4.00 pounds

Material Used for the Enclosure: ALUM/PLASTIC   Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 90

Of the sturctural weight, what % is off-the-shelf? 20

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
PLANT DEVELOPMENT

CODE
BACX0516

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999 M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 9

STATUS
(X) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1992 Number of Flights 2 Duration of Flight, Days 90

OBJECTIVE
DETERMINE THE EFFECTS OF PROLONGED ZERO G ENVIRONMENT ON PLANT DEVELOPMENT FROM FERTILIZED SEEDS AND THRU MULTIPLE GENERATIONS RAISED IN SPACE

DESCRIPTION
FERTILIZED SEEDS OF SEVERED PLANT SPECIES WILL BE SUBJECTED TO EXTENDED ZERO G ENVIRONMENT. THE GROWTH OF THE PLANTS WILL BE PHOTOGRAPHED AND SAMPLES WILL BE RETURNED TO EARTH. THE REMAINING PLANTS WILL BE POLLENATED AND SEED DEVELOPMENT MONITORED. THE PROCESS WILL BE CONTINUALLY REPEATED THRU SEVERAL SUCCEEDING GENERATIONS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC (X) DC

	Power, W	Duration, Hrs/Day
Operating	195	
Standby		
Peak	275	28.00
Voltage, V	28	Frequency, Hz

(X) Continuous

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None   ( ) Realtime   ( ) Offline   (X) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS):   Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog   ( ) Digital   Hours/Day
Film (Amount):   Voice (Hours/Day):
Live TV (Hours/Day): 0.50   Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit)   Downlink command rate:
Recording Rate (KBPS) 1.00   Downlink Frequency (MHz):

THERMAL
(X) Active   ( ) Passive

Temperature, deg C	Operational Minimum	20	Maximum	40
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	195	Maximum	275
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location   (X) Internal   ( ) External   ( ) Remote
Equipment ID/Function   (X) Pressurized   ( ) Unpressurized
Length: 1.10 meters   Width: 0.50 meters   Height: 0.80 meters   (Stowed)
Length: 1.10 meters   Width: 0.50 meters   Height: 0.80 meters   (Deployed)
Launch mass, kg: 70   Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g)   min: max:

CREW REQUIREMENTS
Crew Size   Task Assignments

Skills (See Table B)

Skill	2									
Level	1									
Hours/Day	0.75									

EVA ( ) Yes (X) No   Reason   Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	2	days	Consumables	16	kg
	Returnables	16	kg	Man hours required	16.00	
Configuration Changes:	Interval	30	days	Man-Hours Required		
	Deliverables		kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
(X) Medium
( ) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service	18.2	man-days/year
EVA Service		man-days/year
Experiment Ops		man-days/year
Service Frequency	180.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)	
Length:	meters	Width:	meters	Height:	meters	(Deployed)	

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
FERTILIZED SEEDS OF SEVERED PLANT SPECIES WILL BE SUBJECTED TO EXTENDED ZERO G ENVIRONMENT. THE GROWTH OF THE PLANTS WILL BE PHOTOGRAPHED AND SAMPLES WILL BE RETURNED TO EARTH. THE REMAINING PLANTS WILL BE POLLENATED AND SEED DEVELOPMENT MONITORED. THE PROCESS WILL BE CONTINUALLY REPEATED THRU SEVERAL SUCCEEDING GENERATIONS.

Item Dry Weight: 154 pounds Volume: 53.00 cubic feet

Structural Weight (includes typical "mechanical" items listed below): 150.00 pounds

Design Complexity: 7

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	30 %
Digital	%
Power Supplies	60 %
Other	10 %

Manufacturing Complexity for Electronic Items: 4

Weight of the Circuit Board and Electronics Mounted on it: 4.00 pounds

Material Used for the Enclosure: ALUM/PLASTIC Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 90

Of the sturctural weight, what % is off-the-shelf? 20

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

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PAYLOAD ELEMENT NAME
CLOSED ENVIRON LIFE SUPP SYS

CODE
BACX0517

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A)

CONTACT
Name
Address BOEING AEROSPACE CO
PO BOX 3999, M/S 8C-23
SEATTLE, WA 98124

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 9

STATUS
(X) Operational ( ) Approved ( ) Planned (X) Candidate ( ) Opportunity

Desired First Flight, Year: 1997 Number of Flights Duration of Flight, Days 180

OBJECTIVE
DEVELOP AND DEMONSTRATE TECHNIQUES AND METHODS FOR USE OF BIOLOGICAL SYSTEMS, IN CONJUNCTION WITH MECHANICAL SYSTEMS, TO SUPPORT HUMAN LIFE FOR EXTENDED PERIODS WITHOUT RESUPPLY BY REGENERATION OF WASTE MATERIALS

DESCRIPTION
STARTING WITH SMALL DEMONSTRATION MODELS AND BUILDING AND BIOLOGICAL, BOTANICAL AND MICROBIAL RESEARCH A SYS WILL BE DEVELOPED THAT CAN REGENERATE WASTES INTO USABLE LIFE SUPPORT MATERIALS. THROUGHOUT THE LIFE OF THE STATION LARGER AND MORE COMPLEX CELSS RESEARCH UNITS WILL BE DELIVERED. ULTIMATELY THE STATION MAY OBTAIN A PORTION OF ITS ECLSS FROM THESE RESEARCH UNITS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known):
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
(X) AC (X) DC

	Power, W	Duration, Hrs/Day	
Operating	9690	16.00	
Standby			( ) Continuous
Peak			
Voltage, V	28	Frequency, Hz	60

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): 8.00 Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) 3.15 Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	20	Maximum	40
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum	10	Maximum	17
	Non-operational Minimum		Maximum	

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 3.80 meters Width: 3.80 meters Height: 3.80 meters (Stowed)
Length: 3.80 meters Width: 3.80 meters Height: 3.80 meters (Deployed)
Launch mass, kg: 3273 Return mass, kg:
Consumable Types BIOLOGICAL NUTRIENTS/H20
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size
Task Assignments

Skills (See Table B)

Skill	2										
Level	3										
Hours/Day	0.00										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval		days	Consumables	700	kg
	Returnables	150	kg	Man hours required	24.00	
Configuration Changes:	Interval	180	days	Man-Hours Required	48.00	
	Deliverables	400	kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

(X) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
(X) High

Operations Times

OTV Up/Down		days
OTV or TMS on Orbit		days
Mission Use		days/year
IVA Service		man-days/year
EVA Service		man-days/year
Experiment Ops	547.5	man-days/year
Service Frequency	12.0	times/year

Delta Velocities
Up
Down
Aero Return

Support Equipment

Length:	meters	Width:	meters	Height:	meters	(Stowed)
Length:	meters	Width:	meters	Height:	meters	(Deployed)

Mass: kg

Manifest Restrictions
( ) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
(X) Must have Docking Module

Length of Beam Fab
Number of Appendages
Number of Modules Required to Assemble the Payload

Cost Data

Name and Phone Number: MEL OLESON 3-2020

DESCRIPTION
STARTING WITH SMALL DEMONSTRATION MODELS AND BUILDING AND BIOLOGICAL, BOTANICAL AND MICROBIAL RESEARCH A SYS WILL BE DEVELOPED THAT CAN REGENERATE WASTES INTO USABLE LIFE SUPPORT MATERIALS. THROUGHOUT THE LIFE OF THE STATION LARGER AND MORE COMPLEX CELSS RESEARCH UNITS WILL BE DELIVERED. ULTIMATELY THE STATION MAY OBTAIN A PORTION OF ITS ECLSS FROM THESE RESEARCH UNITS.

Item Dry Weight: 6774 pounds Volume: cubic feet

Structural Weight (includes typical "mechanical" items listed below): 6491.70 pounds

Design Complexity: 8

Manufacturing Complexity for Structural/Mechanical Items:
Typical "mechanical" items include enclosures, optics, motors, blowers, gyros, batteries, cables, connectors, switches, indicators, cathode ray tubes, antennas without electronics, mechanisms, waveguides, etc.

Electronic Equipment Description:

Analog	32 %
Digital	24 %
Power Supplies	31 %
Other	13 %

Manufacturing Complexity for Electronic Items: 8

Weight of the Circuit Board and Electronics Mounted on it: 63.27 pounds

Material Used for the Enclosure: ALUM/PLASTIC Machine Casting? No

Of the electronics weight, what % is off-the-shelf? 30

Of the sturctural weight, what % is off-the-shelf? 25

Manufacturing Degree of Automation

Electronics	(X) Low	( ) Medium	( ) High
Mechanical	(X) Low	( ) Medium	( ) High

Is the item Hardened? No

PAYLOAD ELEMENT NAME
BURN HEALING STUDY

CODE
BACX0020

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name JAMES F KENNEY
Address BOEING CO
PO BOX 3999 MS 8C-61
SEATTLE, WA 98124
(NEED A MEDICAL CO-INVES

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 10

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: 0 Number of Flights 1 Duration of Flight, Days 0

OBJECTIVE
EVALUATE POTENTIAL IMPROVEMENT TO NURSING BURN PATIENTS THROUGH TREATMENT IN ZERO GRAVITY. POTENTIAL IMPROVEMENTS DUE TO 1) EASIER CONTAMINANT (INFECTION) CONTROL 2) ZERO-G MAKES CONTACT ABRASION DUE TO BEDDING GO AWAY.

DESCRIPTION
PERFORM CONTROL EXPERIMENT WITH UNBURNED AND BURNED LABORATORY ANIMALS. BURNED LABORATORY ANIMALS WILL BE INITIALIZED IN AN EARTH LAB AND TRANSPORTED TO SPACE IN A SALINE SOLUTION, AS WELL AS INITIALIZED IN SPACE, WHILE IN SPACE, LABORATORY ANIMALS WILL BE TETHERED INSIDE A SMALL CONTROLLED VOLUME. HEALING RATES WILL BE COMPARED TO COMPARABLE TERRESTRIAL BURN RECOVERY GROUP TREATED CONVENTIONALLY.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km Perigee, km Tolerance + -
Inclination, deg . Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s .

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	1000	
Standby		( ) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:

( ) None ( ) Realtime ( ) Offline ( ) Other: RECORD VITAL SIGNS
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 1.00 W, m: 1.00 H, m: 1.00 Stowed
L, m: 1.00 W, m: 1.00 H, m: 1.00 Deployed
Launch mass, kg: 200 Return mass, kg: 100
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

CREW REQUIREMENTS
Crew Size 1 Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
ESTIMATE 10 LABORATORY ANIMALS AT 1 KG EACH WITH FOOD AND WATER TO LAST THE DURATION OF THE FLIGHT
HABITAT AND LIFE SUPPORT SYSTEMS REQUIRED. MONITORING DONE BY CREW MEMBER.

Boeing-Specific Input Data

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MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width:	0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width:	0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME | CODE
MUSCLE METABOLISM (NMR) | BACX0013

TYPE
(X) Science and Applications (N
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT

Name LAUREL O. SILLERUD LS-3
Address MS M886
LOS ALAMOS NATIONAL LABO
LOS ALAMOS, NM 87545

Telephone (505) 667-2766

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 0

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: 0 Number of Flights 0 Duration of Flight, Days 0

OBJECTIVE
NUCLEAR MAGNETIC RESONANCE MUSCLE METABOLISM EXPERIMENT

DESCRIPTION
IT IS PROPOSED THAT THE CAPABILITY TO DO 31P (AND PERHAPS 13C) NUCLEAR MAGNETIC RESONANCE CHEMICAL SHIFT MEASUREMENTS BE INCORPORATED INTO THE ON-BOARD NMR IMAGING SYSTEM SO THAT NON-INVASIVE STUDIES OF MUSCLE METABOLISM IN VIVO CAN BE PERFORMED IN ORDER TO ASSESS MUSCLES RESPONSE TO ZERO GRAVITY, WITHOUT THE NEED FOR BIOPSY.

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ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	200	
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None (X) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum 500
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: W, m: H, m: Stowed
L, m: W, m: H, m: Deployed
Launch mass, kg: 500 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

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CREW REQUIREMENTS
Crew Size

Task Assignments

Skill							
Level							
Hours/Day							

Skills (See Table B)

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions
THE MAGNET MAY BE PART OF THE NMR BIOMEDICAL IMAGING SYSTEM ALREADY PLANNED.

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer
- ( ) Not Serviced — F
- ( ) Remote TMS — FT
- ( ) Remote Manned — FM
- ( ) Serviced at Station (TMS Retrieved) — FST
- ( ) Serviced at Station (Self-propelled) — FS

Platform Based
- ( ) Not Serviced — P
- ( ) Remote TMS — PT
- ( ) Remote Manned — PM
- ( ) Serviced at Station (TMS Retrieved) — PST
- ( ) Serviced at Station (Self-propelled) — PS

Other
- ( ) Space Station Based — SS
- ( ) Sortie — SOR

CONSTRUCTION/SERVICING COMPLEXITY
- ( ) Low
- ( ) Medium
- ( ) High

ORIGINAL PAGE IS OF POOR QUALITY

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00	meters	Width:	0.00	meters	Height:	0.00	meters	(Stowed)
Length:	0.00	meters	Width:	0.00	meters	Height:	0.00	meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
- (X) No Restrictions
- ( ) Only with compatible payloads
- ( ) Fly-Alone
- ( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
PULMONARY FUNC IN WEIGHTLESSNESS

CODE
BACX0034

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name HAROLD J. GUY MD
Address UCSD SCHOOL OF MEDICINE
LA JOLLA, CA 92093

Telephone 714 452-4190

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 8

STATUS
( ) Operational (X) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights 1 Duration of Flight, Days

OBJECTIVE
TO STUDY THE TOPOGRAPHIC DISTRIBUTION OF GAS AND BLOOD IN THE HUMAN LUNG
IN WEIGHTLESSNESS. TO STUDY OVERALL LUNG FUNCTION IN WEIGHTLESSNESS.
TO STUDY OVERALL LUNG FUNCTION IN WEIGHTLESSNESS.

DESCRIPTION
GRAVITY STRONGLY INFLUENCES THE TOPOGRAPHIC DISTRIBUTION OF BLOOD, AND OF INSPIRED GAS, IN THE LUNG, WHICH I DEFORMED BY GRAVITATIONAL LOADS. AT ZERO G THE DISTRIBUTION SHOULD CHANGE MARKEDLY. WE WILL PERFORM A SERIES OF NON-INVASIVE TESTS, ANALYZING EXPIRED GAS WITH A MASS SPECTROMETER AND USING A SERIES OF INHALED GAS MIXTURES, TO STUDY THIS CHANGE IN BLOOD & GAS DISTRIBUTION. WE WILL ALSO STUDY THE EFFECTS OF THE HEADWARD SHIFT OF BLOOD (GENERAL CONGESTION) THAT OCCURS AT ZERO G. OVERALL LUNG FUNCTION WILL BE INFLUENCED BY THIS

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day	
Operating	100	.50	
Standby			( ) Continuous
Peak			
Voltage, V		Frequency, Hz	

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None (X) Realtime ( ) Offline ( ) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

(X) On-Board Data Processing Required

Description:

Data Types: (X) Analog (X) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C Operational Minimum Maximum

Non-operational Minimum Maximum

Heat Rejection, w Operational Minimum Maximum

Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote

Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: W, m: H, m: Stowed

L, m: W, m: H, m: Deployed

Launch mass, kg: 75 Return mass, kg:

Consumable Types

Acceleration Sensitivity, (g) min: 0.00E+00 max: 0.00E+00

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CREW REQUIREMENTS

Crew Size

Skills (See Table B)

Task Assignments

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg

Returnables, kg Man hours

Configuration Changes: Interval, day Man/Hours Required

Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer
( ) Not Serviced — F
( ) Remote TMS — FT
( ) Remote Manned — FM
( ) Serviced at Station (TMS Retrieved) — FST
( ) Serviced at Station (Self-propelled) — FS

Platform Based
( ) Not Serviced — P
( ) Remote TMS — PT
( ) Remote Manned — PM
( ) Serviced at Station (TMS Retrieved) — PST
( ) Serviced at Station (Self-propelled) — PS

Other
( ) Space Station Based — SS
( ) Sortie — SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times
OTV Up/Down — days
OTV or TMS on Orbit — days
Mission Use — days/year
IVA Service — man-days/year
EVA Service — man-days/year
Experiment Ops — man-days/year
Service Frequency — times/year

Delta Velocities
Up 0.00
Down 0.00
Aero Return 0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab 0.00
Number of Appendages 0
Number of Modules Required to Assemble the Payload 0

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PAYLOAD ELEMENT NAME
PRIMATE FACILITY

CODE
BACX0035

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name DR. CHARLES A. FULLER
Address DIVISION OF BIOMEDICAL S
UNIVERSITY OF CALIFORNIA
RIVERSIDE CA 82521
(714) 781-4617

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale =10

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
EXAMINE THE EFFECTS OF ZERO G ON HOMEOSTASIS IN PRIMATES.

DESCRIPTION
USING A SMALL PRIMATE WE ARE LOOKING AT THE RESPONSES OF SEVERAL VARIABLES (TEMPERATURE, FEEDING, DRINKING, ACTIVITY AND CARDIOVASCULAR) TO SPACEFLIGHT.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + 0 - 0
Inclination, deg ANY Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	400	.50
Standby		
Peak		

( ) Continuous

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
(X) On-Board Data Processing Required
Description:
Data Types: (X) Analog (X) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: 4 W, m: 2 H, m: 2 Stowed
L, m: 4 W, m: 2 H, m: 2 Deployed
Launch mass, kg: 300 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size
Skills (See Table B)

Task Assignments

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

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MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times	
OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities	
Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
SPACELAB 1 GERMAN D-1 MISSION

CODE
BACX0036

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name COGOLI AUGUSTO, PHD
Address LABORATORIUM FÜR BIOCHEM
ETH-ZENTRUM
CH-8092 ZURICH, SWITZERL

Telephone 01/2563135

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 10

STATUS
( ) Operational (X) Approved ( ) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights 3 Duration of Flight, Days

OBJECTIVE
STUDY OF THE ADAPTATION OF SINGLE ANIMAL AND HUMAN CELLS IN CULTURE TO THE SPACE ENVIRONMENT.

DESCRIPTION
HUMAN LYMPHOCYTES FROM CONVENTIONAL DONORS AND FROM CREW MEMBERS WILL BE INVESTIGATED DURING SPACEFLIGHT IN INCUBATOR PROVIDED BY THE PRINCIPAL INVESTIGATOR. THIS IS A BIOMEDICAL PROJECT WHICH SHOULD PROVIDE USEFUL INFORMATION TO BASIC SCIENCE AND TO BIOTECHNOLOGY. THE STUDY OF GROWTH OF HUMAN AND ANIMAL CELLS AT OXG SHALL BE EXTENDED IN THE FUTURE TO A NUMBER OF IMPORTANT CELL SYSTEMS NOT YET INVESTIGATED.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg ANY Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	10	.50
Standby		
Peak	15	
Voltage, V	28	Frequency, Hz

( ) Continuous

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None (X) Realtime ( ) Offline ( ) Other:

( ) Encription/Decription Required

( ) Uplink Required: Command Rate (KBS): Frequency (MHz):

(X) On-Board Data Processing Required

Description:

Data Types: (X) Analog (X) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C Operational Minimum Maximum

Non-operational Minimum Maximum

Heat Rejection, w Operational Minimum Maximum

Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location (X) Internal ( ) External ( ) Remote

Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: .5 W, m: .5 H, m: .5 Stowed

L, m: .5 W, m: .5 H, m: .5 Deployed

Launch mass, kg: 10 Return mass, kg: 0

Consumable Types

Acceleration Sensitivity, (g) min: E+00 max: E+00

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CREW REQUIREMENTS

Crew Size Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg

Returnables, kg Man hours

Configuration Changes: Interval, day Man/Hours Required

Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

THE DATA GIVEN HERE REFERS TO EXPERIMENTS TO BE FLOWN ON THE SPACELAB

I WOULD BE GLAD TO DISCUSS PROJECTS TO BE CONSIDERED FOR MANNED SPACE STATIONS

Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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PAYLOAD ELEMENT NAME
MAMMALION GRAVITY RECEPTOR

CODE
BACX0037

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name MURIEL D. ROSS
Address DEPT OF ANATOMY
THE UNIVERSITY OF MICHIG
ANN ARBOR, MICH 48109

Telephone

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 10

STATUS
( ) Operational ( ) Approved (X) Planned ( ) Candidate ( ) Opportunity

Desired First Flight, Year: Number of Flights 1 Duration of Flight, Days

OBJECTIVE
TO DETERMINE WHETHER MORPHOLOGICAL CHANGES OCCUR IN MAMMALIAN (RAT) GRAVITY RECEPTORS AS A CONSEQUENCE OF SPACE FLIGHT CONDITIONS.

DESCRIPTION
THIS EXPERIMENT ENTAILS THE STUDY OF INNER EAR GRAVITY RECEPTORS FROM RATS EXPOSED TO ALL THE CONDITIONS OF SPACE FLIGHT (THRUST INCREASES IN G-FORCES, VIBRATION, MICROGRAVITY, REENTRY FORCES); FROM OTHER RATS ALLOWS TO READAPT FOR TWO WEEKS POST-FLIGHT; AND, IF POSSIBLE, FROM RATS EUTHANIZED DURING FLIGHT (NO EXPOSURE TO REENTRY FORCES). THE PURPOSE AT FIRST WILL BE TO LEARN WHETHER SHORT-TERM SPACE FLIGHT HAS A DELETERIOUS EFFECT ON THE GRAVITY RECEPTORS. WE ARE DEVELOPING SPECIAL FIXATION PROCEDURES FOR THE IN-FLIGHT COLLECTION OF TISSUES.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC
Power, W Duration, Hrs/Day

Operating
Standby ( ) Continuous
Peak
Voltage, V Frequency, Hz

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime ( ) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL
(X) Active ( ) Passive
Temperature, deg C Operational Minimum Maximum
Non-operational Minimum Maximum
Heat Rejection, w Operational Minimum Maximum
Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS
Location ( ) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
L, m: .5 W, m: .5 H, m: .5 Stowed
L, m: .5 W, m: .5 H, m: .5 Deployed
Launch mass, kg: 10 Return mass, kg:
Consumable Types
Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill						
Level						
Hours/Day						

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE
Service: Interval, days Consumables, kg
Returnables, kg Man hours
Configuration Changes: Interval, day Man/Hours Required
Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

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Boeing-Specific Input Data

MISSION TYPE	OPS CODE
Free Flyer	
( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS
Platform Based	
( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS
Other	
( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY
- ( ) Low
- ( ) Medium
- ( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Stowed)
Length:	0.00 meters	Width:	0.00 meters	Height:	0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions
- (X) No Restrictions
- ( ) Only with compatible payloads
- ( ) Fly-Alone
- ( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

PAYLOAD ELEMENT NAME
GENETIC ENG/VEGETATION SPECIES I

CODE
BACX0040

TYPE
(X) Science and Applications (Non-comm.)
( ) Commercial
( ) Technology Development
( ) Operations
( ) Other
( ) National Security
Type number (see table A) 4

CONTACT
Name BOB BARKER
Address ST. REGIS PAPER CO
435 CLARK ROAD
JACKSONVILLE, FL

Telephone 904 764-0545

Importance of the Space Station to this Element
1 = Low Value, But Could Use
10 = Vital
Scale = 10

STATUS
( ) Operational ( ) Approved ( ) Planned ( ) Candidate (X) Opportunity

Desired First Flight, Year: Number of Flights Duration of Flight, Days

OBJECTIVE
DERIVE IMPROVED STRAINS OF VEGETATION (OF SPECIFIC INTEREST TO THE RESPONDENT ARE TREES) BY GENETIC ENGINEERING IN ZERO-G.

DESCRIPTION
RESEARCH AND DEVELOPMENT IN A ZERO-GRAVITY LABORATORY WITH VEGETATION TISSUE CULTURES AND GENETIC COMBINATION MAY BE ABLE TO INDUCE PURE STRAINS OF OFFSPRING THAT ARE NOT POSSIBLE ON EARTH FOR IMPROVED DISEASE RESISTANCE, MORE EFFICIENT SOLAR ENERGY CONVERSION, IMPROVED RATE OF GROWTH, IMPROVED NUTRITIVE VALUE, ABILITY TO GROW IN LESS THAN FRIENDLY SOILS AND ENVIRONMENTS.

ORBIT CHARACTERISTICS
Geosynchronous Orbit ( ) Yes (X) No
Apogee, km ANY Perigee, km ANY Tolerance + -
Inclination, deg Tolerance + -
Nodal Angle, deg Ephemeris Accuracy, m
Escape dV Required, m/s

POINTING/ORIENTATION
View Direction ( ) Inertial ( ) Solar ( ) Earth (X) Any
Truth Sites (if known)
Pointing Accuracy, arc-sec Field of View (deg)
Pointing Stability (Jitter), arc-sec/sec
Special Restrictions (Avoidance)

POWER
( ) AC ( ) DC

	Power, W	Duration, Hrs/Day
Operating	10	
Standby		( ) Continuous
Peak		

Voltage, V Frequency, Hz

DATA/COMMUNICATIONS

Monitoring Requirements:

( ) None ( ) Realtime ( ) Offline ( ) Other:

( ) Encription/Decription Required

(X) Uplink Required: Command Rate (KBS): Frequency (MHz):

(X) On-Board Data Processing Required

Description:

Data Types: (X) Analog (X) Digital Hours/Day

Film (Amount): Voice (Hours/Day):

Live TV (Hours/Day): Other:

On-Board Storage (Mbit):

Data Dump Frequency (Per Orbit) Downlink command rate:

Recording Rate (KBPS) Downlink Frequency (MHz):

THERMAL

(X) Active ( ) Passive

Temperature, deg C Operational Minimum Maximum

Non-operational Minimum Maximum

Heat Rejection, w Operational Minimum Maximum

Non-operational Minimum Maximum

EQUIPMENT PHYSICAL CHARACTERISTICS

Location ( ) Internal ( ) External ( ) Remote

Equipment ID/Function (X) Pressurized ( ) Unpressurized

L, m: .50 W, m: .50 H, m: .50 Stowed

L, m: .50 W, m: .50 H, m: .50 Deployed

Launch mass, kg: 10 Return mass, kg:

Consumable Types

Acceleration Sensitivity, (g) min: E+00 max: E+00

CREW REQUIREMENTS

Crew Size

Task Assignments

Skills (See Table B)

Skill							
Level							
Hours/Day							

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service: Interval, days Consumables, kg

Returnables, kg Man hours

Configuration Changes: Interval, day Man/Hours Required

Deliverables, kg Returnables, kg

SPECIAL CONSIDERATIONS/See Instructions

Boeing-Specific Input Data

MISSION TYPE — OPS CODE

Free Flyer

( ) Not Serviced	F
( ) Remote TMS	FT
( ) Remote Manned	FM
( ) Serviced at Station (TMS Retrieved)	FST
( ) Serviced at Station (Self-propelled)	FS

Platform Based

( ) Not Serviced	P
( ) Remote TMS	PT
( ) Remote Manned	PM
( ) Serviced at Station (TMS Retrieved)	PST
( ) Serviced at Station (Self-propelled)	PS

Other

( ) Space Station Based	SS
( ) Sortie	SOR

CONSTRUCTION/SERVICING COMPLEXITY

( ) Low
( ) Medium
( ) High

Operations Times

OTV Up/Down	days
OTV or TMS on Orbit	days
Mission Use	days/year
IVA Service	man-days/year
EVA Service	man-days/year
Experiment Ops	man-days/year
Service Frequency	times/year

Delta Velocities

Up	0.00
Down	0.00
Aero Return	0.00

Support Equipment

Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Stowed)
Length: 0.00 meters	Width: 0.00 meters	Height: 0.00 meters	(Deployed)

Mass: 0 kg

Manifest Restrictions

(X) No Restrictions
( ) Only with compatible payloads
( ) Fly-Alone
( ) Must have Docking Module

Length of Beam Fab	0.00
Number of Appendages	0
Number of Modules Required to Assemble the Payload	0

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7.1.5.4 SAI User Requirements Survey

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NASA SPACE STATION USER REQUIREMENTS SURVEY

January 12, 1983

Conducted for:

Boeing Aerospace Co.
Seattle, WA

By:

Science Applications, Inc.
1055 Wall St., Suite 200
La Jolla, CA 92037

SCIENCE APPLICATIONS, LA JOLLA, CALIFORNIA
ALBUQUERQUE • ANN ARBOR • ARLINGTON • ATLANTA • BOSTON • CHICAGO • HUNTSVILLE
LOS ANGELES • McLEAN • PALO ALTO • SANTA BARBARA • SUNNYVALE • TUCSON

P.O. Box 2351, 1200 Prospect Street, La Jolla, California 92037

TABLE OF CONTENTS

1. INTRODUCTION

Science Applications, Inc. (SAI) was tasked by Boeing Aerospace Co. to compile a User Requirements Survey in the areas of biological, life, and medical sciences for incorporation into an overall document describing the needs, attributes, and options of a proposed NASA Space Station. In order to accomplish this task, SAI was to compile a list of representative users of such a facility, and interview them with respect to their needs and future space research plans. This report represents a compilation of the results of those discussions, the contributions of our in-house life sciences staff, and input from researchers associated with the Bio-Med Research Institute (a local, non-profit organization affiliated with SAI).

It should be noted that this effort followed a prior one initiated by Boeing personnel which involved the mailing of a multi-page questionnaire to a number of potential users. Response to this mailing was extremely light, and in conducting our survey we included several of the Boeing-identified research personnel in an effort to ascertain why. The universal response was that the forms were not applicable to the "real situation", and that the right questions were not asked. For example, most of the instrumentation needed functions within a very narrow range of physical conditions, whereas the forms were oriented toward stress conditions. As a result, most respondents put the forms aside. Appendix A to this document illustrates a sample response to the form, and illustrates the above-mentioned drawbacks.

Accordingly, in interviewing the respondents, SAI personnel concentrated on the following five questions:

1) Are you currently involved in aerospace research?

2) If so, in what areas?

3) Which of those areas (and if possible, which specific protocols) would you wish to study, given a space station environment?

4) What specific physical conditions do you require? Which specific physical conditions are deleterious to your work?

5) What specific equipment, data analysis/computing, space, and crew time needs do you have?

From the responses to these questions, SAI personnel identified general areas of research to be addressed, and within those, a prioritization was developed. Appendices B and C respectively provide a list of individuals contacted, and four sample interview summaries. The report text which follows has been organized as follows.

Chapter 2 outlines the general experimental considerations and needs which must be addressed in designing a program of study in the areas of biological, life, and medical sciences. These are subdivided into two areas; bacterial/viral, cellular, and plant; and higher mammal and human. Chapter 3 describes those considerations defined to be of highest priority as experimental groups; that is, potential experimental protocols are grouped according to similarity of purpose and equipment need. Chapter 4 provides a list of the equipment needed to support the experimental protocols delineated under Chapter 3. Lastly, Chapter 5 summarizes our findings. References are provided, followed by Appendices A (Sample Questionnaire), B (List of Contacts), and C (Sample Interview Summaries).

2. GENERAL EXPERIMENTAL CONSIDERATIONS

The theoretical biologist is challenged by numerous concepts related to space travel, microgravity environments, and biological functions. Many investigations into aspects of the effects of microgravity on biological systems have already been conducted. These experiments range from the "practical" consideration of physiological effects in space craft personnel to the more "erudite". In the current state of ignorance in which biologists find themselves regarding the influences of prolonged exposure to the conditions of space travel and habitation, it appears prudent to refrain from hastily condemning any group of biological experiments as "esoteric". For practical considerations it is necessary, however, to establish priorities in experiments which would be considered for inclusion aboard the planned initial flights of the Space Station. Experimental requirements such as mass, size, equipment, and supplies must all be calculated into the myriad of physical and design constraints surrounding a project of the magnitude and importance of the proposed Space Station. It would be most valuable then to be able to maximize the "return" of information on such experimental "investments".

This concept of "return" is far more nebulous and difficult to assess than the physical parameters of experimental demands. Albeit conceptual in character, requiring subjective judgments of "intrinsic worth" on the parts of the individuals involved in the implementation of the project, nonetheless, the judgments must be made so that progress on the space station project can occur at all.

Accordingly, the following text outlines those biological and physiological processes and conditions that, on the basis of our survey, appear to be of first priority. In addition, the specific measurements and parameters which should be taken and studied in order to investigate those processes and conditions are identified.

2.1 BACTERIAL/VIRAL, CELLULAR, AND HORTICULTURAL CONSIDERATIONS

Bacterial and viral cultures under the conditions of a space station provide the opportunity to observe the isolated trophic effects of light, growth media, gaseous concentrations, gravity (and the absence thereof), vibration, temperature, motion, noise, and radiation. These studies done under actual conditions would be valuable. Little consideration has apparently been given to the possible mutational influences of background radiation and "heavy" particle exposures which could occur in bacterial and viral organisms finding their way aboard space craft as inadvertant opportunistic contaminants. Such organisms could be contained in equipment and/or supplies, or may even be organisms normally found in the respiratory, gastrointestinal, or integumentary systems of the crew members. The mutational influences of ionizing radiation on bacteria and viruses is well established. Determination of whether similar mutations occur under space travel conditions, what the mutations are, and the consequences of such mutations would be extremely valuable. Concomitant with this area should be the consideration of sampling the "void" of space for the possible existence of "life" forms similar to our viruses.

Along similar lines, cellular cultures could be observed for growth effects resulting from the external influences previously listed. In addition, the unique characteristics of support matrix dependence and independence evidenced by different types of cells in culture should be evaluated under extra terrestrial conditions. Finally, the parameter known as contact inhibition (i.e., inhibition of cell growth due to physical contact with another cell) may be markedly influenced in cells cultured under the low or zero gravity conditions described.

A great deal has been published on the influence of noise, light, vibration, motion, temperature, and humidity on the growth of higher plants. Gravity effects at zero "g" levels and at one "g" and above prove somewhat uninteresting with respect to plant growth. Gravity effects on growth, however, between 0 and 1 g are virtually unknown in the area of the higher plants. Radiation effects at present do not appear to be of much significance in horticulture; however, further studies under the unique conditions of microgravity and radiation exposure may prove more valuable. Determining the possibility of, and optimum conditions for, plant growth under space station conditions could provide one simple method for regeneration of the ambient atmosphere for crew members.

2.2 HIGHER MAMMAL AND HUMAN CONSIDERATIONS

Human physiological considerations are manifold under the independent and combined influences of space flight. The vestibular functions of balance and coordination are known to be markedly affected by microgravity conditions. "Space sickness" is a well described entity which has practical ramifications in conducting ongoing space travel experiments in general, as evidenced in the most recent space shuttle flight. Background noise, vibration, and motion may also be important components of this syndrome. Temperature, radiation, and light levels outside the "normal" terrestrial envelope, or wide fluctuations within that range may also function as contributing factors. Lastly, mixtures of breathing gases may add to the effect.

Related to "space sickness" and its influence on the total organism are effects on eye-hand coordination, ocular muscle movements, and reaction times. These functions may be influenced directly by the external factors delineated, or indirectly by the effects of those factors on nerve conduction times, muscular contractile force generation, kinesthesia, stereognosis, sleep, and exercise. More fundamental physiological processes which may also be affected and which in turn affect organ system functions are the utilization of energy at the cellular level, tissue oxygenation, electrolyte content of the body fluids, and elimination of metabolic wastes. Clearly, the syndrome of "space sickness" provides a wide opportunity for physiological experiments.

Venous return, normally enhanced by gravity in the Superior Vena Cava and counteracted in the Inferior Vena Cava (major vessels leading to the heart), may now be significantly changed under low gravity conditions. Central venous pressure measurements, cardiac output, vascular volume, pulmonary wedge pressures, ballistocardiograms, and electrocardiograms will all be very important parameters of study under microgravity conditions.

Muscle tonus and boney mineralization are also influenced dramatically by gravity. The "unloading" of bones in microgravity leads to calcium and phosphorus shifts which could in turn affect vascular volume; and intravascular, as well as inter- and intracellular electrolyte concentrations. Decreased muscle tonus in microgravity leads to muscle atrophy with attendant shifts in body mass, and body fluid compositions.

A unique consideration not previously entertained with respect to the sedentation accompanying prolonged space travel and microgravity conditions, is that cardiorespiratory physical conditioning is essentially unavailable. These effects normally lead to decreased serum lipid levels, and to a more favorable oxygen extraction coefficient. Sedentation, combined with the decreased resistances met in microgravity situations, should therefore lead to elevation of serum lipid levels. Higher serum lipids change the surface tension of red cell membranes (the oxygen carriers of the bloodstream) and lead to rouleaux formations which in turn cause microvascular circulatory compromise, decreased tissue respiratory exchange, a relative tissue hypoxemia, and less favorable oxygen extraction coefficients. Lethargy, sleepiness, and decreased reaction times result, which could seriously affect the conduct of the mission. Accordingly, experiments involving physiological factors (e.g., measurement of serum lipids, electrolytes, vascular volume, hemoglobin, hematocrit, red cell indices, reticulocyte count, and oxygen extraction coefficients) will prove valuable, to immediate monitoring of mission progress, to the study of long-term space residence effects, and consequently, to the planning of the space exploration program itself.

Reaction time, alertness, cognition, stereognosis, kinesthesia, and orientation are extremely important neurological functions which may be influenced by any number of the stimuli and changes previously discussed. Nerve conduction and muscular contraction, influenced either directly or indirectly, play a primary role in neuromuscular coordination and function.

Still another important neurological consideration is [redacted] the development of a "sleep deprivation psychosis" which accompanies prolonged periods in which the human being is prevented from entering into the "Rapid Eye Movement" (REM) phase of the sleep cycle. Such a psychosis displays characteristics such as irrational and destructive behavior, paranoia, hostility, depression, and suicidal tendencies. The rigors of a space station crew's duties and the disruption of the normal circadian rhythm of light and dark predispose personnel to the development of this clinical syndrome. Though studied extensively under terrestrial gravitational conditions, little is known about the added complication of microgravity and its effect on the normal sleep pattern. The potential consequences of the appearance of this syndrome during an actual mission are obvious. Electroencephalograms, electromyograms, sleep experiments and nerve conduction time studies if performed on board, would contribute to the overall body of knowledge needed to determine what men can or cannot do in space.

Whenever the subject of radiation is discussed the biologist must always consider its effects on the immunological and hematopoietic systems. A further consideration is that lymphatic flow is greatly influenced by gravitational effects. Production of lymph is a function of the hydrostatic pressure (blood pressure plus gravitational effects), tissue oncotic pressure, and vascular permeability versus the opposing forces of intravascular oncotic pressure and "muscle pumping." The near or complete absence of gravity could theoretically lead to decreased lymphatic flow through regional lymph nodes which comprise the "first line of defense" against systemic infection. Accordingly, on-board investigations dealing with bone marrow examinations, peripheral total and differential white cell count determinations, immunoprotein electrophoresis, and mixed lymphocyte cultures could aid in elucidating these influences.

With the possibilities of changes in vascular volume, body fluid compositions, and cardiovascular function as previously discussed, a consideration of renal function must be included. Studies of urine composition, urinary volumes (obligate and 24 hours total) glomerular filtration rate, blood urea nitrogen (BUN), creatinine level, and creatinine clearance are all appropriate contributors to the overall physiological studies objective.

Bowel transit time and attendant fecal excretion, fecal ammoniacal nitrogen concentration, and bacterial flora levels and species may prove signifcant in crew members maintained on "compact" space age diets. Studies of these parameters may influence significantly the dietary provisions for future space flight experiments.

No functional evaluation of the effects of space conditions on human biological systems would be complete without a consideration of metabolism and related factors. Tissue level energy utilization, metabolic free radical formation, and enzyme kinetics are but a few of the subjects suggested for study under the conditions described. Tissue catalase levels; liver, kidney, and muscle enzyme determinations; blood glucose, insulin, total serum protein levels, and albumin globulin ratios; testosterone (and where appropriate, estrogen) levels; thyroid T_3, T_4 levels; and diurnal serum cortisol levels would all prove invaluably informative.

One final area of huge importance to the evaluation of biological systems under conditions of a space station lies in the area of reproduction. The observations of mating, conception, gestation and parturition of a mammalian system in this environment could influence our knowledge and approach for future space exploration efforts immensely.

3. SPECIFIC EXPERIMENTAL PROTOCOLS

This report now turns to the specific identification of experiments which by virtue of their informational return value, assigns them greater priority than others under consideration. As previously stated, those experiments of equal informational value with others (as based on our survey and literature review results), that require the least differentiated experimental designs, will be favored. A final factor affecting the selection of candidate experiment types is the long range goal of the entire space exploration program.

Obviously, one thing which must be determined early on in such an exploration program is whether it is at all possible for biological systems (humans or higher mammals) to be kept functional and viable under exposure to the influences of a space station environment. As a result, those experiments which meet the previously-mentioned criteria, and which at the same time contribute to the realization of the long range goals of the space exploration program will be assigned the highest priority, and are listed as Phase 1 experiments.

These experiments are described under a "Group Number" designator - the intent being to define an experimental area, identify the goals to be accomplished through study of that area, and to provide a rationale for the same. Most importantly, no priority is suggested by the group number; these are used simply as identifiers.

PHASE I

GROUP 1 EXPERIMENTS:

Description: Bacterial and viral culture experiments.

Purpose: Study of the effects of environmental influences (extant in a space station) upon simple bacterial and viral biological systems.

Goals:
1) To determine growth rates for bacteria and viruses.
2) To determine the frequency, nature, and extent of mutations occurring in the studied systems.
3) To determine if opportunistic contamination of supplies, equipment, and physical facilities occurs.
4) To culture and identify the organisms obtained in "3" and study in parallel with other study systems mentioned.
5) To sample the "void" of space for "life" forms which might be present and similar to viruses. Study as outlined in "4".
6) To study the "normal flora" bacteria and viruses present in the respiratory, gastrointestinal, and integumentary systems of space station personnel as outlined in "1-2" previously.

Discussion and Rationale:

This group of experiments will provide valuable information regarding fundamental biological processes as influenced by the environmental stimuli present. They will point to possible hazards and risks of returning to earth life forms without "natural" occurrence and hence without opposing "natural" forces of balance. Data will be provided as to probabilities of infection of crew members by mutant bacteria and viruses which could prove crippling to further space exploration experiments. The experiments themselves would require only general laboratory apparatus and specific facilities for culture of such organisms, all of which are readily available and adaptable to other experiments which might suggest themselves.

PHASE I

GROUP 2 EXPERIMENTS:

Description: Cell culture experiments.

Purpose: Study of the environmental influences extant in A SPACE STATION upon simple cell culture systems.

Goals:

1) To determine growth rates of cell cultures.
2) To determine the frequency, nature, and extent of mutations in the cells cultured.
3) To observe the effects of space station conditions on the characteristics of support dependent and independent cell culture systems.
4) To observe the effects of space station conditions on the process of "contact inhibition" in cell culture systems.

Discussion and Rationale:

These experiments, while requiring only general laboratory apparatus and some specific supplies and equipment related to cell culture, will provide valuable data related to cellular events in mammalian cells. Extrapolation by inference from these data will provide insight into possible problems which might arise in crew members of future space exploration experiments. The equipment required enjoys adaptability as well as shared function with other experiments outlined for this Phase.

PHASE I

GROUP 3 EXPERIMENTS:

Description: Horticulture under space station conditions.

Purpose: Study of the environmental influences extant in a space station on the culture of higher plant forms.

Goals:
1) To determine optimal growth parameters for higher plants.
2) To study the independent effects of ionizing radiation and microgravity on higher plant growth.
3) To determine the feasibility of space station atmospheric regeneration by higher plant forms.

Discussion and Rationale:

The importance of maintaining a proper atmosphere in which crew members of space exploration experiments can live and function is obvious. The data gathered from these experiments will add significantly to the knowledge required to adapt a model of atmospheric regeneration by higher plant forms to space flight. These data may prove fundamental for later mechanical or chemical models of atmospheric regeneration systems. Though the experimental equipment and supplies for such an experimental group are somewhat specialized and specific, it is felt that the information to be obtained outweighs this disadvantage.

PHASE I

GROUP 4 EXPERIMENTS:

Description: Physiological experiments on human subjects

Purpose: Study of space station environmental influences on the physiological responses of human subjects.

Goals:
1) Electroencephalographic monitoring of subjects during wakefulness and sleep, as well as during light and dark cycles.
2) Ballistocardiographic measurements of subjects at rest and during exercise.
3) Electrocardiographic monitoring of subjects at rest and during exercise.
4) Electromyographic measurements on subjects.
5) Stereognosis studies of objects with similar shape and size but different mass in subjects.
6) Kinesthetic studies with subjects.

Discussion and Rationale:

These experiments will serve the dual purpose of information-gathering with respect to subject performance under ambient space station conditions, as well as early detection systems for possible deleterious effects on crew members for the parameters studied.

PHASE I

GROUP 5 EXPERIMENTS:

Description: Physiological experiments on the squirrel monkey

Purpose: Study of space station environmental influences on the physiological responses of the squirrel monkey.

Goals:
1) Monitoring of central venous pressure.
2) Monitoring of cardiac output.
3) Monitoring of vascular volume.
4) Monitoring of pulmonary wedge pressure.
5) Determination of nerve conduction time.

Discussion and Rationale:

Important physiologic parameters will be monitored for inferential application to man. These invasive procedures are designated to animal studies first, to preclude unforeseen complications from occurring in human subjects. Data obtained here will have direct application by inference to human subjects and help determine the overall expected performance efficiency of crew members under space station conditions.

PHASE I

GROUP 6 EXPERIMENTS:

Description: Biochemical experiments on human subjects

Purpose: Study of variations in biochemical parameters in the human subject under space station environmental influnces.

Goals: 1) Measure serum lipids, electrolytes, immunoproteins, blood urea nitrogen (BUN), CPK and its isoenzymes, SGOT, SGPT, LDH, Alkaline Phosphatase, total and direct bilirubin, calcium, phosphorus, serum ammonia, glucose, insulin levels, total serum proteins, albumin globulin ratios, testosterone (estrogen if appropriate) thyroid T_3, T_4, diurnal cortisols, creatinine, urine composition, urinary volumes (obligate and 24 hours total), creatinine clearance.

Discussion and Rationale:

The measurement of these parameters are invaluable as functional determinants and early warning monitors of crew members exposed to harmful stimuli. These tests have for the most part been well standardized and the majority of their determinations can be conducted on modularized analytical instruments, each of which will perform a multitude of the individual tests mentioned.

PHASE I

GROUP 7 EXPERIMENTS:

Description: Immunological experiments on human subjects

Purpose: Study variations in immunological parameters in human beings exposed to the space station environment.

Goals:
1) To study bone marrow responses to environmental stimuli.
2) To study environmental influences on lymph production.
3) To conduct mixed lymphocyte cultures, on lymphocytes isolated from human subjects, for responsiveness to antigenic stimuli after space station environmental exposure.

Discussion and Rationale:

These studies will provide important information regarding human subject tolerance of space station environmental stimuli with respect to immunological function. They will also provide early warning monitors of deleterious exposures experienced by crew members. Most equipment shares function with other cell culture and hematologic experiments previously described.

4. EQUIPMENT AND SUPPLIES LIST (PHASE I EXPERIMENTS)

Dishes, Petri	- prepoured media - assorted types - supply variable with experimental demands - some media require refrigerated storage - approximate weight = 100 Kgs (for estimated total supply)
Loops, Wire	- for bacteriologic and viral cultures - supply variable with experimental demands - approximate weight = 2 Kgs (for estimated total supply)
Incubator	- environmentally controlled - temperature ±0.1°C; humidity ±1% variation; gas concentrations ±1%. Approximate weight = 32 Kgs
Gases, Assorted	- purity >99.9 - N_2, O_2, CO_2, compressed air - supply variable with experimental demands - approximate weight = 50 Kg/cylinder
Water, Purified	- HPLC/reagent grade - volume variable with experimental demands - approximate weight = 1 Kg/lite
Swabs, Culturette	- preloaded transport media - 2 boxes - approximate weight = 1 Kg
Microscope	- binocular - phase contrast - UV - photomicrographic format capabilities - 115V - approximate weight = 30 Kg
Storage	- refrigeration - 10 cubic feet - approximate weight = 136 Kg
Aspirator System	- microorganism detection - with filters and/or columns for microorganism collection - approximate weight = 15 Kg
Bottles	- cell culture - roller system - supply variable with experimental demands, refrigerated storage - approximate weight = 50 Kg
Medium	- cell culture - various solutions for cell culture - supply varies with experimental demands - approximate weight = 50 Kg
Culture, Cell Device	- motorized unit for rotation and incubation of cell cultures - approximate weight = 50 Kg
Stains	- cell culture - assorted, for cell culture experiments - approximate weight = 10 Kg

Plants, Assorted	-	for horticultural experiments - approximate weight = 50 Kg
Support Material	-	plant - mixed types - approximate weight = 100 Kg
Centrifuges	-	four assorted with head attachments capable of 0-1 G force development - approximate weight = 120 Kg
Microprocessor	-	with analogue to digital signal processing capability, 512 K RAM - approximate weight = 30 Kg
Recorders, Video	-	two each - approximate weight = 50 Kg
Green House	-	plant growth facility - $\pm$0.1°C temperature - $\pm$1% humidity; $\pm$1% gaseous concentration control; 100 cubic feet volume - approximate weight = 250 Kg
Monitors	-	atmospheric - with column sampling capabilities - approximate weight = 28 Kg
Chromatograph, gas	-	Perkin-Elmer, microprocessor controlled - 115V - approximate weight = 36 Kg
Electro Encephalograph	-	multichannel - 115V - approximate weight = 150 Kg
Ballistocardiograph	-	with transducers, hard copy printout and CRT - 115V - approximate weight = 100 Kg
Electrocardiograph	-	multichannel - shielded cable - 115V - approximate weight = 50 Kg
Electromyograph	-	multichannel - CRT - 115V - approximate weight = 62 Kg
Monitor, Physiologic	-	multichannel, CRT, printout - 115V - approximate weight = 60 Kg
Accessories	-	physiologic monitor - transducers - cables - paper - catheters - approximate weight = 12 Kg
Freezer	-	subzero - sample storage - 10 cubic feet - 115V - approximate weight = 150 Kg
Autoanalyzer	-	blood and serum - with reagent carpules - "ACA" type - approximate weight = 300 Kg
Accessories	-	phlebotomy - vacutainer type - tourniquets - needles - prep wipes - approximate weight = 40 Kg

Needles	-	bone marrow biopsy - Jam - SHIDI - University of Illinois types - approximate total weight = 1 Kg
Autoclave, Steam	-	three cubic feet - 115V - approximate weight = 35 Kg
Autoclave, Gas	-	three cubic feet - 115V - approximate weight = 35 Kg
Cages, Mouse	-	with accessories for food and water - bedding material - waste disposal - approximate weight = 150 Kg
Mice	-	genetically standardized - for breeding experiments - 50 in number - approximate weight = 1 Kg
Cages, Monkey	-	four - and accessories - approximate weight = 75 Kg
Monkeys, Squirrel	-	four - with rations, etc. - approximate weight = 100 Kg
Instruments and Supplies	-	weight allowance for undesignated small supplies and equipment items - approximate weight = 20% of total weight of payload defined.

5. SUMMARY

Our survey and literature review results clearly indicated that the research personnel active in the field of space science share several concerns regarding future studies to be conducted onboard a space station:

- o Prioritization of experiments; near-term studies must provide data regarding the long-term viability of such a research platform
- o Control of on-board environmental conditions
- o Provision of adequate and unique on-board computing capabilities

These are further discussed below.

As outlined in Chapter 2, several questions remain regarding the viability of a research platform such as a space station over the long-term. While ambient radiation levels are not deemed critical for higher plant studies, they may be to the animals and humans onboard. Time and level of exposure would then become significant factors affecting experiment length and station residence times. Accordingly, it would be of advantage to give priority to those experiments which deal with these parameters.

Control of on-board environmental conditions was also stressed, particularly in the areas of temperature control, noise, stability, and radiation. With respect to temperature, it was stressed that although researchers can define a temperature range or tolerance within which their experiments may work, once a set point within that range was chosen, temperature control must be within ± 0.25 degrees of the set point.

Noise levels must not exceed a specified decibel level, as excessive noise levels may have deleterious physiological effects on both plant and animal organisms under study. Similarly, station stability must fall within a particular tolerance level; studies using higher plants have shown that they may be adversely affected by increased levels of vibration. Laboratory position on a space station ring (inner versus outer) may affect cellular growth by as much as a factor of two. Radiation has already been discussed in conjunction with the long-term prospect, but excessive levels may also directly affect the conduct of experiments.

Finally, a universal requirement surfaced regarding the on-board computing capabilities required. Most researchers favored dedicating an on-board microprocessor system to the conduct of this work, particularly since those having shuttle experience found the on-board NASA facilities inadequate. In fact, many have already adapted off-the-shelf hardware and software equipment for their needs.

In closing, it should be stated that the majority of researchers contacted in the course of this study responded with enthusiasm to the concept of a space station research platform, and look forward to the implementation of the concept. However, most also felt that the key to the success of such a venture, particularly in the area of the life sciences and biomedical research, lay in the establishment of a good communications channel between the scientific research community, and the engineering design and construction staff.

APPENDIX A

MISSION NAME	CODE	TYPE

CONTACT (Name address, phone)

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President – Biomedical Research Institute of America.
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La Jolla, California 92038

STATUS

- ☐ Operational
- ☐ Approved
- ☐ Planned
- ☑ Candidate
- ☐ Opportunity

Year of first flight ____________

Number of missions ____________

OBJECTIVE

EVALUATE BIOLOGICAL EFFECTS OF LONG TERM ~~[illegible]~~ SPACE RESIDENCE

TYPE

Science and Applications

- ☐ Astrophysics
- ☐ Communications
- ☐ Earth and Planetary Exp.
- ☐ Environmental Observations
- ☑ Life Sciences
- ☐ Materials Processing

Commercial

- ☐ Earth and Ocean Operations
- ☐ Communications
- ☐ Materials Processing
- ☐ Industrial Research

National Security

- ☐ Research and Development
- ☐ Operational

Technology Development

- ☐ Generic
- ☐ Flight Missions
- ☐ Operations
- ☐ Basic Physics and Chemistry

DESCRIPTION

This Project Provides a General Medical Research/Biological Research Laboratory CAPABILITY – Severl Different Types of Experiments/Tests and Physical (Astronaut) Evaluations ARE Possible with the Proposed Facility

ORBIT CHARACTERISTICS

Apogee, km ______ Perigee ______ Tolerance ± ______

Inclination, deg ______ Tolerance ± ______

Argument of perigee, deg ______ Ephemeris accuracy ______

Synchronization ☑ None ☐ Earth ☐ Sun ☐ Other ______

POINTING(Real Time)

View direction ☐ Inertial ☐ Solar ☐ Earth ☑ Other It doesn't matter.

Pointing accuracy ______ Field of view ______

Specific targets Stability angle ______

DATA/COMMUNICATIONS

Monitoring requirements ☐ None ☑ Realtime ☑ Offline ☐ Other

Data rate Variable Frequency, Hz ______ Bandwidth, Hz ______

☑ Onboard data processing Data storage, kB 1 Million plus

☐ Encryption/Decryption required

POWER

	Power, W	Duration, hr
Operating		
Standby		
Peak		

Voltage, V 120 Frequency, Hz ______

Duty Cycle Description

ORBIT TRANSFER STAGE (IF KNOWN)

☐ PAM-A ☐ PAM-D ☐ IUS

THERMAL

Type of concept maintain Normal Room Temperature

Temperature, deg C ~20 Operational min ______ max ______ Peak ______

Cryogenic Load ______ Temperature ______ Duration ______

Heat Rejection, W Operational ______ Peak ______

CREW REQUIREMENTS

Estimated crew size Permanent 2 Service 1 EVA ☐ Yes ☐ No

Manhours/mission 155 to 310 Average time between visits, days 30

Skills required PhD Medical/Biological Research Lab Technician/Engineer

PHYSICAL CHARACTERISTICS — See Report

Launch mass, kg ______ Deployed mass ______ Expendables ______

Length, m Launch w/OTV ______ Undeployed ______ Deployed ______

Diameter, m Launch ______ Undeployed ______ Deployed ______

Center of gravity location, m X ______ Y ______ Z ______

SPECIAL CONSIDERATIONS/CLARIFICATIONS	SKETCH
The ATTACHED REPORT DESCRIBES NATURE OF THE VARIOUS EXPERIMENTS AND THE TYPE OF EQUIPMENT, THE WEIGHT OF EQUIPMENT/INSTRUMENTS AND THEIR SPACE AND TEMPERATURE REQUIREMENTS.	HAVE ARCHITECT REFERENCE THE ABOVE REPORT

APPENDIX B

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APPENDIX C

Dr. Suzanne Churchill
Department of Physiology
Harvard Medical School
25 Shattuck Street
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Includes:
Dr. F. Sulzman
Dr. M. Moore-Ede

Part of staff on a project entitled "Fluid and Electrolyte Homeostasis", P.I. of Project - Dr. Martin C. Moore-Ede

SPACE STATION WORK

Objective: Study cardiovascular and renal adaptations to chronic spacelessness in the squirrel monkey

Plans: To continue as a space station comes into being

Specific Equipment:
1) 4 squirrel monkeys (with cages, etc.)
2) Automation capability for data acquisition, control functions, data processing (currently uses a PDP-1134, but could scale down)
3) Need an HP 4 channel recording multiplexer having signal conditioners with pressure transducers. Must also have a chart drive mechanism.

General Needs:
1) Standard biomedical laboratory setup
2) Surgical Capacity - adequate for emergency requirements

Dr. Wadi Suki
Baylor College of Medicine
The Methodist Hospital
Houston, TX 77030
(713) 790-3275

Currently working with two NASA scientists at the Johnson Space Center on a study investigating fluid electrolyte balance in the crew during flight. (Urine and blood samples are taken and analyzed.) He is also independently doing the same work using bed rest to simulate space flight.

SPACE STATION WORK

Objective: Continue above studies; protocol is constant, and no differing studies are anticipated. Samples would be drawn in space, centrifuged, stored. Analysis will be done on earth.

Equipment:
1) Centrifuge to spin samples down
2) No computing or data processing
3) Storage facilities (refrigerated)

Dr. E. Morton Bradbury, Ph.D.
Department of Biochemistry
University of California at Davis
School of Medicine
Davis, CA 95616
(916) 752-2929

A cell biologist, currently working on aspects of cell growth and division.

SPACE STATION WORK

Objective: Continue studies on cell growth and division under space station conditions. Examine effects of zero "g" on growth, division, reproduction.

Equipment Needs:
1) Standard microbiological set-up
2) Microscopes
3) Precise temperature control

Dr. Allen Brown
Department of Biology
University City Science Center
University of Pennsylvania
Philadelphia, PA 19104
(215) 898-7807

Dr. Brown is a plant physiologist with prior space research experience; he has had experiments on both the first and second space shuttle missions, and has already been approved to fly an experiment on the next shuttle mission.

SPACE STATION WORK

Objective: To study the validity of using plant systems for regeneration of atmospheres by examining the life cycles of higher plants under weightless conditions to see if any aberrations occur in their life cycles. If some are detected, determine what level of gravity will correct same. (This study was approved for SPACELAB, then cancelled when program cut.) He is not concerned with devising apparatus for atmosphere regeneration, although he believes this to be a long-term NASA goal.

Specific Equipment:

1) 100-150 kg mass of plant and support material
2) 4 centrifuges capable of creating G-forces from 0-1
3) Power; constant level of 10 watts, peaks of 40 watts
4) Signal processing capability
5) Microprocessor; currently flying an APPLE
6) 2 videotape recorders (does not use NASA's videostorage capability)

General Needs: 1) Standard basic plant growth facilities

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7.1.5.5 Dornier Life Sciencies Report

DATA/COMMUNICATIONS
Monitoring Requirements:
( ) None ( ) Realtime (X) Offline ( ) Other:
( ) Encription/Decription Required
( ) Uplink Required: Command Rate (KBS): Frequency (MHz):
( ) On-Board Data Processing Required
Description:
Data Types: ( ) Analog ( ) Digital Hours/Day
Film (Amount): Voice (Hours/Day):
Live TV (Hours/Day): Other:
On-Board Storage (Mbit):
Data Dump Frequency (Per Orbit) Downlink command rate:
Recording Rate (KBPS) Downlink Frequency (MHz):

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THERMAL
(X) Active ( ) Passive

Temperature, deg C	Operational Minimum	18	Maximum	32
	Non-operational Minimum		Maximum	
Heat Rejection, W	Operational Minimum		Maximum	
	Non-operational Minimum	47	Maximum	1251

EQUIPMENT PHYSICAL CHARACTERISTICS
Location (X) Internal ( ) External ( ) Remote
Equipment ID/Function (X) Pressurized ( ) Unpressurized
Length: 1.10 meters Width: 1.20 meters Height: 1.00 meters (Stowed)
Length: meters Width: meters Height: meters (Deployed)
Launch mass, kg: 97 Return mass, kg: 0
Consumable Types
Acceleration Sensitivity, (g) min: max:

CREW REQUIREMENTS
Crew Size

Task Assignments

Skills (See Table B)

Skill	2										
Level	1										
Hours/Day	0.50										

EVA ( ) Yes (X) No Reason Hours/EVA

SERVICING/MAINTENANCE

Service:	Interval	90	days	Consumables		kg
	Returnables		kg	Man hours required	8.00	
Configuration Changes:	Interval	90	days	Man-Hours Required	16.00	
	Deliverables		kg	Returnables		kg

SPECIAL CONSIDERATIONS/See Instructions

DORNIER SYSTEM

Participation in NASA Space Station Study

TITLE: LIFE SCIENCES ON A SPACE STATION
TITEL:

DOCUMENT NO.: TN-SSS-DS-004
DOKUMENT NR:

ISSUE NO.: -
AUSGABE NR:

ISSUE DATE: 16.02.1983
AUSGABEDATUM:

PREPARED BY: Dr. A.I. Skoog
BEARBEITET:

COMPANY: Dornier System GmbH
FIRMA:

CONTRACT NO :

A. Ingemar Skoog

PROJECT MANAGER
PROJEKTMANAGER

TABLE OF CONTENTS

1. INTRODUCTION

Microgravity research plays a very important role in the European Space Programme and a series of major life sciences payloads are planned for the 1980's. Except for the German D1 mission the missions presently foreseen are all organized by the European Space Agency (ESA), e.g. the First Spacelab Payload on STS-9 and EURECA, with experiments from the various member states of ESA. Some ESA payloads like Biorack and the SLED will be flown on the German D1 mission.

The present ESA planning for life sciences payloads and the development of necessary equipment and technologies therefore in the 1980's, together with trends for the 1990's, forms the basis for the definition of a potential use of a Space Station for life sciences research and technology development. As for trends for the 1990's important inputs and ideas have been gathered by means of a German users workshop and discussions with various scientist and from Dornier inhouse experience in life sciences research and the development of advanced life support systems.

The life sciences users community has shown a very strong interest in the potential use of a Space Station for 1990's. Their first identification of tentative experiments and likely continuations of scientific investigations contain a very precise and detailed description of requirements and necessary equipment. This enables an elaboration of fairly well defined mission criteria, Space Station requirements and mission planning.

This study has been performed based on available ESA planning and payload information, German planning and the results of discussions with the German life sciences community and the first "workshop for potential users of future Space Platforms".

One of many definitions used for the subdisciplines in space related life sciences is:

- Gravitational Biology,
- Radiation Biology,
- Exobiology,
- Human Physiology and Medicine,
  and
- Life Support Systems.

In this study Human Physiology and Medicine, and Life Support Systems are discussed separately. This is due to their character as spacecraft subsystems and crew support in their applied from in the post experimental stage.
Therefore under the general heading life sciences are meant gravitational biology, radiation biology and exobiology with their character of fundamental sciences research.

Concerning bioprocessing, this is regarded as material processing due to its direct commercial application.

2. EUROPEAN ACTIVITIES IN THE 1980's

The Life Sciences activities during the 1980's in Europe are characterized by the ESA Microgravity Research Programme and the therein foreseen flight opportunities (e.g. First Spacelab Payload (FSLP) and EURECA) (Fig. 2.1), and national missions like the German D1. The various research elements in these programmes require the development and initial use of a large number of hardware items. This equipment will then be available as proven hardware, once the Space Station will become available for more elaborate life sciences and human physiology research, and applied space medicine in the early 1990's.

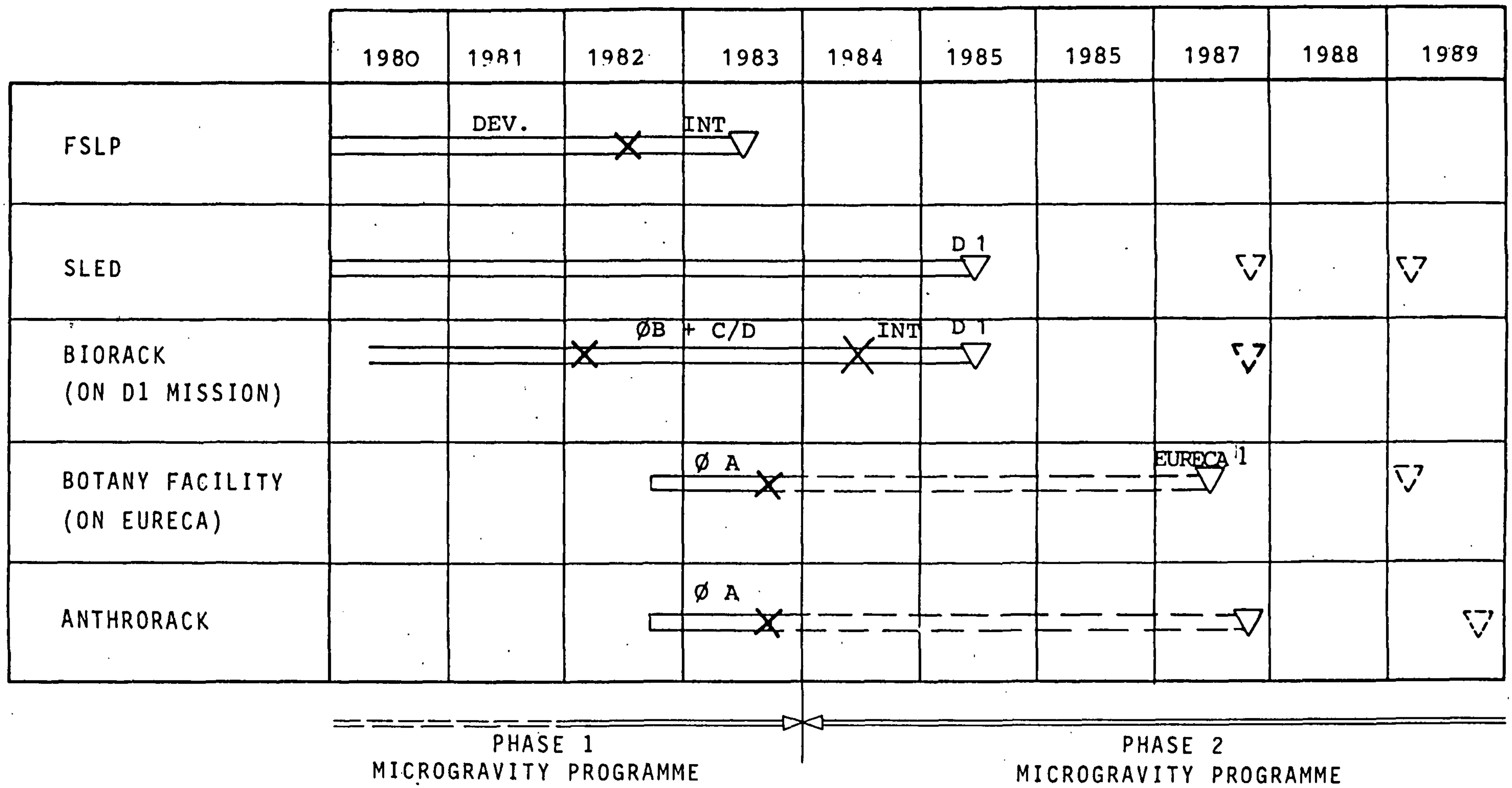

Fig. 2.1: EUROPEAN LIFE SCIENCE ACTIVITIES

▽ = POTENTIAL REFLIGHT OPPORTUNITY

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2.1 Life Sciences

The major life sciences research facilities in the ESA Microgravity Research Programme are the:

- FSLP Experiments,
- BIORACK, and
- BOTANY FACILITY.

These multiuser facilities will be flown once or several times before the initial Space Station.
The general scientific goals of the European and ESA programmes are to study:

- transport processes and mechanicsms at cellular level,
- role of gravity for orientation purposes,
- gravity effects on development/genetics,
- processing at gravity vector information,
- adaptive processes to microgravity,
- radiation responses, and
- genesis of life.

European life sciences experiments on the First Spacelab Payload (FSLP) to fly on STS-9 in September 1983 are:

- the influence of exposure to hard space environment on living matter at cellular level (microorganisms and biomolecules), and
- advanced Biostack experiment to determine the radiobiological importance of HZE particles.

In addition US experiments on e.g. geotropismus will also be part of the FSLP. The Biostack experiment is a continuation of European experiments flown on Apollo 16 and 17, and Apollo-Soyuz.

The BIORACK is a multi-purpose experiment facility to enable biological investigations to be carried out on board Spacelab on such life forms as plants, tissues, cells, bacteria and insects (Fig. 2.2). Its purpose is to determine the effects of zero-g and the space radiation environment on the behaviour of these life forms. The BIORACK will also carry facilities for performing 1-g reference measurements in order to allow for a discrimination between zero-g and radiation effects.

The BIORACK will contain the following equipment:

- Incubator with dynamic range 18-30 °C, controlled to ± 0.5 °C.
- Incubator with dynamic range 30-40 °C, controlled to ± 0.5 °C.
- Cooler compartment operating at approximately 4 °C.
- Freezer compartment operating at -15 °C.
- Glove box.
- Standardized experiment containers.
- 1-g centrifuges.
- Auxiliary investigation equipment (microscopes, cameras etc.).

The ESA BIORACK consists of a single SL RACK (Fig. 2.2) and it is planned to be flown for the first time on the German D 1 mission in 1985.

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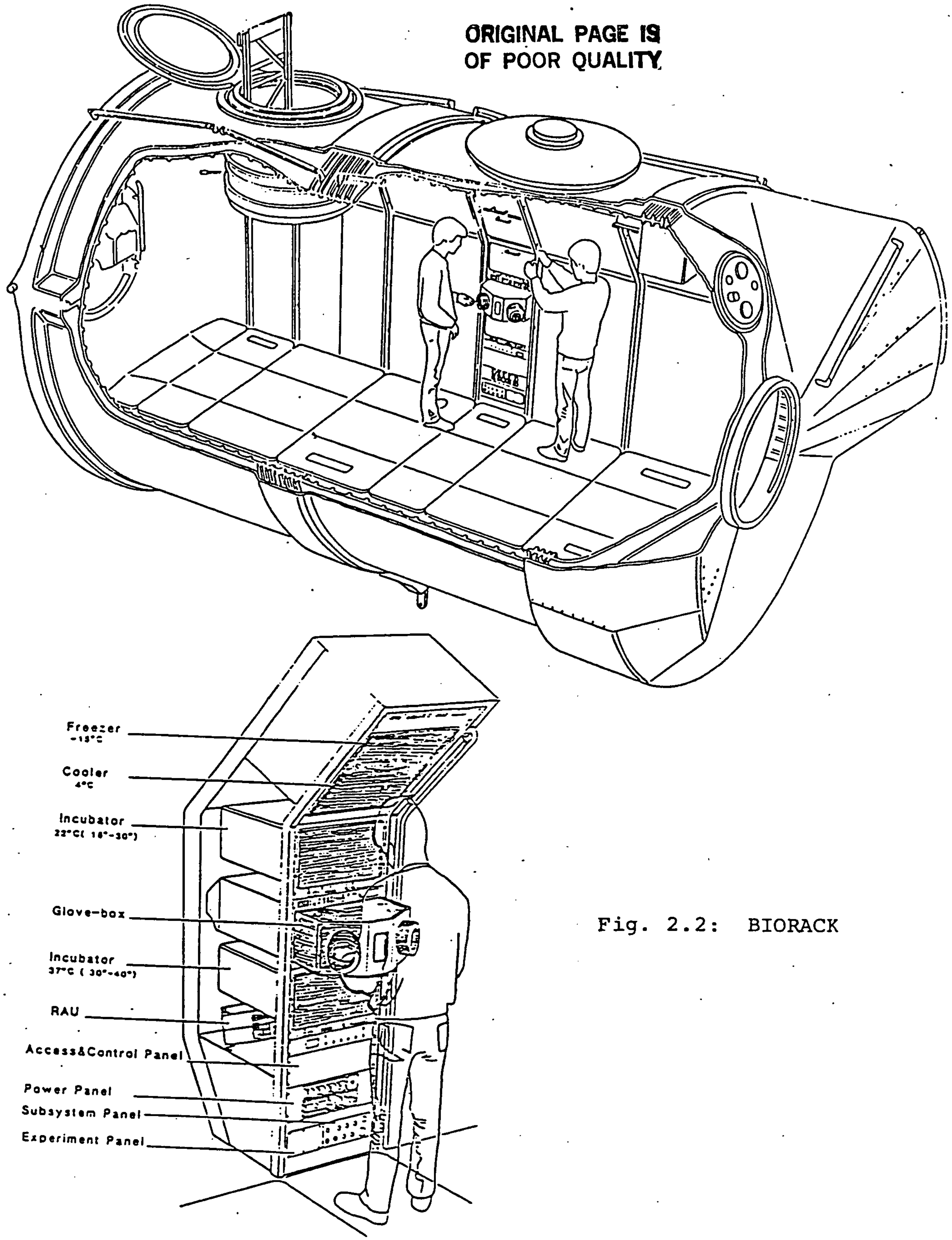

Fig. 2.2: BIORACK

The BOTANY FACILITY multiuser facility is part of the EURECA core payload.
The first EURECA (European Retrievable Carrier) flight will be used to extend and consolidate investigations initiated on FSLP and the D1 mission with a payload consisting of second generation facilities developed to exploit the longer mission duration (2-6 months) and the low "noise" mission opportunities (unmanned platform). The BOTANY FACILITY is intended for the observation of growth of higher plants and fungi. Samples will develop from inert form to inert form during the EURECA mission, where a typical experiment protocol could be:

- introduction of dry seeds or spores in orbit,
- addition of water/nutrient,
- growth and observation,
- fruiting, and
- recovery of dryseeds/spores.

For this purpose more complex and automated experiment equipment will be needed (Fig. 2.3):

- Controllable temperature in the range $\pm 15 \div 30^{\circ}C$ at $\pm$ 0.5°C.
- Dual experiment facilities (one at micro-g and one mounted on a 1-g control centrifuge).
- Illumination at 5000 lux for plant growth.
- Air and CO_2 supply.
- Automatic water and nutrient supply.
- Data acquisition incl. slow motion video.
- Pollination system.

The BOTANY FACILITY is envisaged to fly on the first EURECA mission in 1987 with reflight opportunities every 1.5-2 years.

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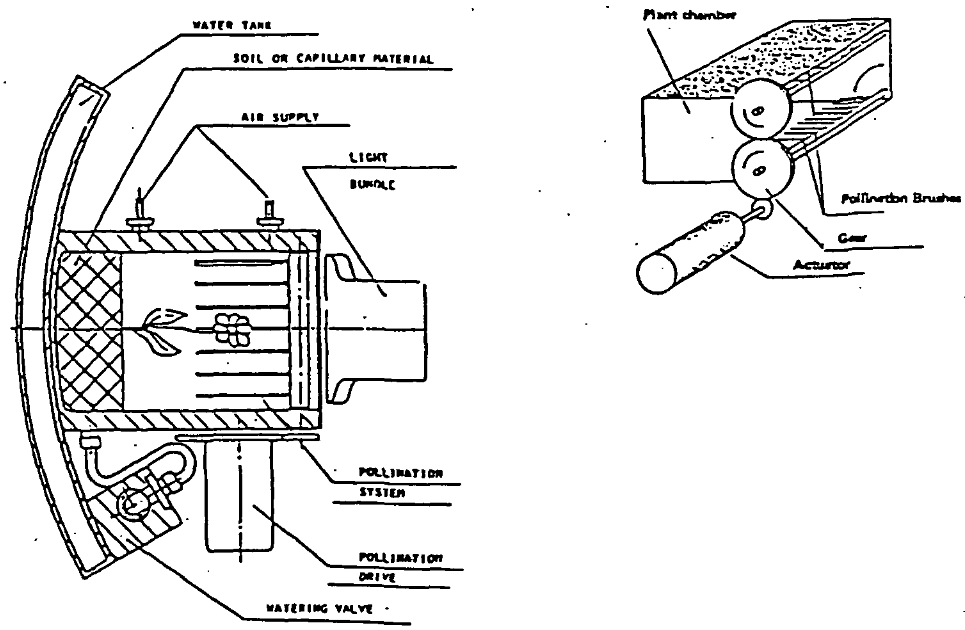

PLANT FACILITY
CULTURE CHAMBER FOR PLANTS

Fig. 2.3: BOTANY FACILITY

The development of required equipment for BIORACK and BOTANY FACILITY is supported by the ESA Technology Research Programme (Fig. 2.4). It is to be noted that the facilities intended for flight in 1987-88 in Fig. 2.4 are automated facilities for the unmanned platform EURECA. Furthermore it is expected that by the end of this decade life science missions will include small mammals, and subsequently holding units for these must be developed in the period 1984-89.

FACILITIES/FUNCTIONS	80	81	82	83	84	85	86	87	88
BIOSAMPLE PRESERVATION, OBSERVATION & HANDLING									
Glovebox development	+++	+++	xxx	****	oooo	F			
Mini-Life Support Systems				--+	++xxx	****	oooo	F	
Preservation Techniques and Facilities			--	--+	++++	****	oooo	F	
					+++++	++++	xxxx	****	oooo
Observation Facilities				--++	+xxx	****	oooo	F	
Containment and Transport Facilities			--	--+	++++	****	oooo	F	
					-----	++++	xxxx	****	oooo
Dynamic Cooler		-----	++++	++++	xxxx	****	oooo	F	
LIFE SCIENCE CONTROL EXPERIMENT FACILITIES									
One 'g' centrifuge	-	-----	++++	+***	oooo	F			

KEY

----- Definition

+++++ Critical Items B.B.

xxxxx B.B. System

***** EM

ooooo Operational Hardware

F Flight Opportunity

Fig. 2.4: ESA Life Science Facility Development Plans

2.2 Human Physiology in Space

A major role in the ESA Microgravity Research Programme during its second phase in the latter part of this decade will be given to the human physiology research and medicine in space. The planned activities are the:

- FSLP Human Physiology Experiments,
- SLED and Improved SLED, and
- ANTHRORACK.

The main scientific objectives for the European human physiology research programme are to study:

- man under microgravity conditions,
- inflight general symptomatology,
- cardiovascular changes,
- tolerance to gravitation,
- fluid loss,
- detraining,
- calcium loss,
- neurosensory changes, and
- space sickness.

The first European astronauts will be on board the FSLP in order to perform the following human physiology experiments:

- mass discrimination between equal objects of different mass,
- blood samples for hormonal analyses,
- ballistocardography (accelerometers taped to subject will determine stroke volume etc.),
- electrophysiological tape recorder testing (ECG, EEG, EOG, and EMG),
- central venous pressure measurement,
- lymphocyte proliferation, and
- vestibular/sensori-motor function research.

The FSLP is the first SPACELAB and European astronaut mission to take place in September 1983. This mission (STS-9) is a combined US/European mission.

The SLED (Fig. 2.5) experiment objectives are to study:

- the response mechanisms of the human sensory balance system to inertial forces in the abscence of earth gravity forces,
- the interactions between balance (inertial), visual, audio and other physical sensations, and
- ways of alleviating the problems of space sickness.

The SLED will fly the first time on the German D1 mission in 1985.

An Improved SLED with a gimballed seat, additional acceleration profiles at increased levels is presently being analysed for a potential operational use about 1986-88.

ANTHRORACK is a human physiology research facility for Spacelab adapted to fit a double-rack configuration. The scientific goals are to study human physiology during microgravity in the field of:

- cardiovascular and pulmonary function and adaptation,
- metabolic processes and adaptation, and
- sensori-motor function and adaptation.

The ANTHRORACK facility will consists of service elements and experiment specific equipment:

- Service Elements
  . Data handling subsystem, computer, keyboard, screen, data storage
  . Blood and urine sampling kits and storage

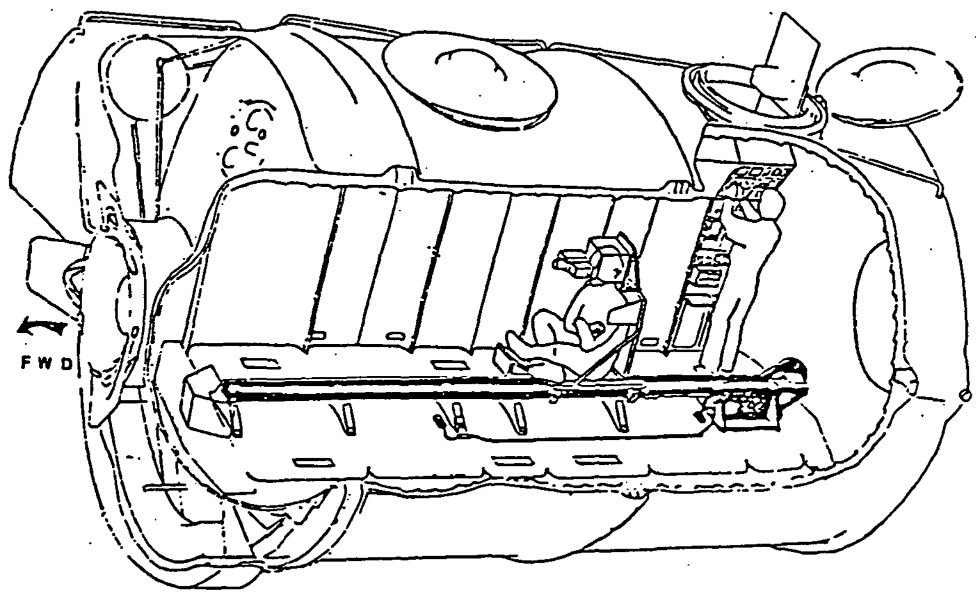

Fig. 2.5: ESA SPACELAB SLED

- Freezer, cooler
- Centrifuge
- General storage for equipment, waste disposal
- Voice recording system
- Respiratory monitoring system, with gas analyses
- General purpose amplifiers (EMG, EOG, EEG, ECG, ESG)
- Monitoring ambient temperature and pressure
- High-resolution TV camera
- Peripheral blood pressure measuring system
- Plethysmograph
- Ergometer, dynamometers
- Pulse generator, visual pattern generator, visual task generator
- Joystick

– Experiment Specific Equipment
  - Ocular pressure measurement device
  - Ophtalmoscope
  - Central venous pressure measurement
  - Ultrasound techniques
    - tissue compliance
    - central and peripheral blood flow
    - blood density
    - cardiac output by echocardiography
  - Eye movement recording via imaging techniques
  - Photo-optical sensor
  - Heart rate laser sensor
  - Laser doppler skin blood flow
  - Rotating chair

- Linear motion device (oscillations and short range)
- Posture platform
- Stimulation/recording equipment for active/passive arm movements.

The preliminary planning foresees the first mission of ANTHRO-RACK in 1987.
The human physiology research programme is supported by the development of critical hardware items within the framework of the ESA Technology Research Programme (Fig. 2.6).

To be considered, when planning for future human physiology research, are also the results of French tests onboard the Russian Salyut space station which started in 1982 (e.g. ultrasound cardiography and posture platform experiments).

2.3 Life Support

The present SPACELAB life support system is using the same open-loop technology as used in the SHUTTLE ORBITER. Systems of this type are adequate for mission durations of up to 2-3 weeks for crew sizes in the order of 4-7 persons. For longer missions and/or crews regenerable systems for:

- CO_2 removal,
- water reclamation, and
- oxygen recovery

will become inevitable, and various concepts on a physico-chemical basis have already been developed in the U.S..

FACILITIES/FUNCTIONS	80	81	82	83	84	85	86	87	88
SPACE MEDICINE FACILITIES									
Breath to Breath gas analyser			--	--++x	x***	oooo			
Ultra-Sound Imaging Instrumentation				-----	++++	++++	xxxx	****	oooo
Non-Invasive Body Function Monitoring				-----	---+	++++	++++	xxxx	oooo
Thermographic monitoring				-----	++++	xx**	oooo	F	

KEY

----- Definition

+++++ Critical Items B.B.

xxxxx B.B. System

***** EM

ooooo Operational Hardware

F Flight Opportunity

Fig. 2.6: ESA Space Medicine Facilities Development Plan

They will be flown on various SL missions as experiments before final implementation in an improved SHUTTLE/SPACELAB or in the SPACE STATION.
Europe will make use of these new regenerable technologies for improved and enhanced SPACELAB capabilities, as has already been studied in the SPACELAB Follow-On Development Programme.

In parallel here to various types of experiment dedicated life support systems for plants, lower vertebrates and small mammalians are under development to support the various types of life sciences experiments planned in Europe for the 1985-89 period.

3. LIFE SCIENCES IN THE 1990's

3.1 Objectives

Two of the most important characteristics in life sciences research are the relatively slow biological processes, and the high complexity and less predictable course of the experiments. This implicates long durations for the experiments and an active involvement of man in their performance as an experimentor and sometimes as a test subject as well. This is also why the life sciences community shows such a strong interest in the use of future Space Stations.

The Space Station will provide new capabilities like:

- long term missions with crew-changes about every 90 days,
- larger crews,
- higher power, and
- more space.

With these new opportunities some of the most hampering limitations for the Shuttle/Spacelab use would be removed and new mission scenarios for life sciences research in the 1990's can be depicted. New ideas of potential experiments and their related equipment have been gathered through close contact with the life sciences community in Europe, mainly in Germany.

Following major scientifical topics have been identified as likely candidates for space research in the 1990's

- Gravitational Biology
  - Gravity Detecting Mechanisms.
  - Processing of Gravity Vector Information.
  - Cell Differentiation.
  - Genetics and Reproduction.
  - Embrogynesis and Organogenesis.
  - Adaptation to Microgravity
  - Combined Effects (e.g. with Radiation and Biological Rythm).
- Radiation Biology
  - Genetics.
  - Cell Differentiation.
  - Radiation Protection.
  - Combined Effects.
- Exobiology
  - Origin of Life.
  - Survival of Living Specimen in Space.
  - Interplanetary Transfer of Life.

3.2 Mission Drivers

The major parameters for identification of mission drivers are:

- mission duration,
- gravity level,
- radiation, and
- crew involvement.

Mission duration requirements range from about a week up to several years for the various mission objectives listed above. The primary effects of micro-gravity or radiation can be detected in general within less than a week of exposure to the space environment, but secondary or genetic effects can only be investigated through multi-generation tests in space i.e. by means of a Space Station. This requires the possibility to cultivate plants and breed animals over several generations in space.

The mission driver as for gravitational conditions is the gravitational biology, which in general requires an environment of less than 10^{-4} g. Concerning radiation, the radiation biology experiments involve exposure to the cosmic radiation mainly the HZE-particles and the heavy ions. Of particular interest is also the combined effect of microgravity and cosmic radiation, which requires a controlled microgravity environment. In order to exactly relate the results of various experiments, in particular those which could have combined effects, to the influence of a particular characteristic of the space environment, most scientists require reference centrifuges for plants and animals.

A crew involvement is required for the execution of most mission objectives, but in particular for the gravitational biology ones. Certain experiments involving animals, especially primates, require an extensive crew participation.

3.3 Equipment

A preliminary list of major equipment for the defined objectives has been established based on the scientific requirements.

- Gravitational Biology Experiments
  - Incubators for microorganisms, plants, and lower vertebrates.
  - Holding facilities for plants and animals (lower vertebrates and smaller mammalians, later primates).
  - Cytological Laboratory.
  - Development-physiological Laboratory.
  - Centrifuges for sample analysis.
  - Centrifuges for plants and animals (O-1 g and 1 g-reference centrifuges).
  - Collers/Freezers.
- Radiation Biology Experiments
  - Radiation measuring devices.
  - Incubators and laboratory equipments as for Gravitational Biology Experiments.
- Exobiological Experiments
  - Facilities for space environment exposure (vacuum, UV, HZE, extreme temperatures).
  - Radiation measuring devices.
  - Incubators for microorganisms.
  - Cytological Laboratory.

Some of this equipment like incubators, holding facilities for plants and animals, and centrifuges are under development in Europe (FSLP and D1 missions) and in the U.S. (Life Sciences Laboratory Equipment, LSLE, and Life Sciences Flight Experiments Program, LSFEP). New and improved versions already tested in space will be available in time for the early Space Station operations.

Other equipment like e.g. cytological and development physiological laboratories are still to be developed and tested.

3.4 Space Station Relevance

The analysis of mission criteria for the life sciences disciplines (Table 3.1) shows as major driving requirements for the utilization of a Space Station the:

- microgravity : $< 10^{-4}$ g for some experiments,
- mission duration : week up to several years, and
- crew involvement : High to medium; as experimentor and test subject.

The mission duration is beyond what can be achieved with the present (1 week) and planned enhanced (3 weeks) capability of the Shuttle/Spacelab. In the 1990's mission durations of months and years will be mandatory in order to investigate e.g. generic effects of microgravity and cosmic radiation. As for species like microorganisms, plants and insects the long term missions could be flown on unmanned platforms like EURECA. As for animals (lower vertebrates and mammalians) manned stations are inevitable, the longer the mission the stronger is the requirement of the presence of man to handle the test subjects (e.g. for several generations).

Furthermore the scientific experiments and investigations will become more and more sophisticated and complex in the future as the result of a logical evolution of the scientific goals and available means. This will make automation of experiment programmes more and more difficult and very expensive.

Table 3.1: MISSION CRITERIA FOR LIFE SCIENCES

RESEARCH OBJECTIVE / MISSION CRITERIA	COSMIC RADIATION	MICRO GRAVITY	VACUUM	CONTROLLED ATMOSPHERE	MISSION DURATION	CREW INVOLVEMENT	INCLINATION & ORBIT	TEST SUBJECTS				TEST PLATFORM		REMARKS
								MICRO-ORGANISMS	PLANTS	ANIMALS	CREW	SPACE STATION	UNMANNED FREE FLYER	
GRAVITATIONAL BIOLOGY	(Controlled)	$\leq 10^{-4}$g	-	X	1week up to several years	high	Standard	X	X	X	X	X	(X)	Some experiments can be automated for unmanned platforms. Radiation levels to be controlled to determine combined effects
RADIATION BIOLOGY	X	$\sim 10^{-3}$g	-	X	1week up to several years	medium	57^o, 400km	X	X	X	-	X	X	Gravity level controlled to determine combined effects. Radiation: HZE and heavy ions.
EXOBIOLOGY	X	$\sim 10^{-3}$g	X	-	1week up to years	low	Standard	X	-	-	-	X	X	Gravity level controlled to determine combined effects, Radiation: Solar,UV Add. crit. ext.temp.

A potential limitation on a manned Space Station is the microgravity environment for gravitational biology. If the station is of an operations character some interference with the microgravity experiments could occur. Countermeasurements are detailed mission planning and dedicated research modules or stations.

3.5 Mission Implementation

Based on the mission objectives and the required equipment, a tentative schedule for the implementation and evolution of the life sciences research programme on a future Space Station has been established (Table 3.2).

With an Initial Space Station available around 1990, some equipment will be available through previous research activities in the 1980's (e.g. incubators, holding facilities and centrifuges). Other equipment like work station and laboratories will have to be developed for the scientific programme planned for the Space Station.

The growing use of animals and increased mission durations will make it necessary to implement a separate Animal Holding Module outside research and habitable areas of the station. Ultimately a dedicated module for a Life Sciences Research Laboratory will become necessary in the latter part of the decade. The Animal Holding Module could be a part of this module. Typical Space Station requirements for the Life Sciences research have been elaborated based on requirements for hardware presently under development and anticipated trends for hardware to be used on a Space Station (Table 3.3).

Table 3.2: LIFE SCIENCES TIME PHASING

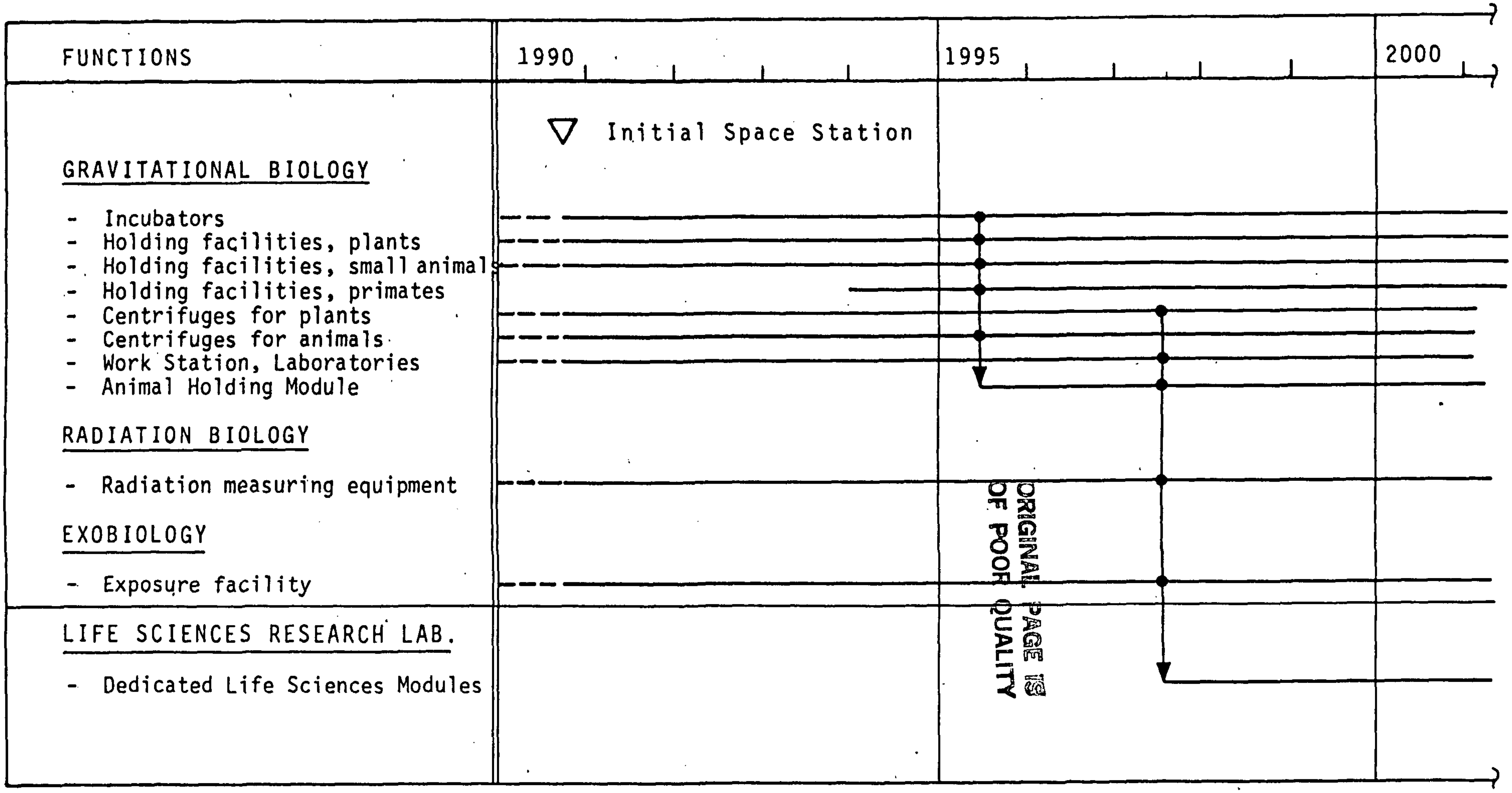

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Table 3.3 : TYPICAL SPACE STATION REQUIREMENTS FOR LIFE SCIENCES

RESEARCH OBJECTIVE / SPACE STATION REQUIREMENTS	MISSION DURATION	MICRO-GRAVITY	MASS	VOLUME	POWER	CREW TIME	REMARKS
	DAYS	g	kg	m^3	kW	hrs/d	
GRAVITATIONAL BIOLOGY	8-60	$<10^{-4}$	25-100	0.1-0.5	0.1-1	0.5	CONTROLLED RADIATION LEVEL GENERAL REQ.
	8-90					1-2	
	30-180		100-300	1-2	0.1-1	0.5	REFERENCE CENTRIFUGES
						1-2	
	1-2 years		500	3-5	1-3	1-2	LARGER ANIMAL HOLDING FACILITIES
			300-600	2-3	1-3	1-2	DOUBLE RACK RESEARCH FACILITIES
RADIATION BIOLOGY	8-60 1-2 years or more	10^{-3}	25-100	0.1-0.5	0.1-0.5	1-2	CONTROLLED GRAVITY LEVEL
EXOBIOLOGY	8-365 1-5 years	10^{-3}	25-100	0.1-0.5	0.1-0.2	0.5	SOLAR, UV RADIATION. VACUUM. EXTREME TEMPERATURE
LIFE SCIENCES RESEARCH LAB	90-	10^{-3} to 10^{-4}	10.000-12.000	60-70	5-7	TBD	COULD INCLUDE ANIMAL HOLDING MODULE

4. HUMAN PHYSIOLOGY AND MEDICINE IN THE 1990's

4.1 Objectives

With a permanent presence of man in space, increasing crew sizes and prolonged missions a systematic research on the reaction and adaptation of man to microgravity and radiation will become a major activity on the Space Station.

The adaptation to microgravity and the possibility to perform daily routine work outside the pressurized modules will become a key issue as to the long term planning for Space Stations and operations in space.
The long term missions with Shuttle revisits every 90 days or even less also call for the development of adequate crew health care and medical support.

Necessary research objectives are:

- Human physiology
  - Cardiovascular functions,
  - Respiration kinetics,
  - Vestibular functions,
  - Metabolism, homone balance and immune system changes,
  - Changes in bones and muscles,
  - Long term effects of space radiation,
  - Fluid and electrolyte changes, and
  - Psycology and human behavior.

- Medicine
  - Diagnostic equipment development,
  - Responses to pharmaceuticals,
  - Research on invasive treatment procedures,
  - Health care/exercise equipment, and
  - Therapeutic capabilities for e.g.
    bonefracture
    burns,
    bleeding wounds,
    toxication,
    decompression,
    dental care,
    contusions, and
    acute surgical situations.

4.2 Mission Drivers

The principle mission driver is the presence of man on the Space Station.
The results of the research activities in human physiology in the 1980's and more intensively onboard the Space Station will set the final requirements for crew stay time, radiation protection measures, working capabilities and safety precautions.

The possibilities to develop adequate medical care and therapeutic procedures will have an influence on the safety concept and emergency procedures of the Space Station as it will grow. With increasing crewnumbers and mission durations the likelihood of an accident between Shuttle revisits will increase. Adequate medical treatment opportunities will therefore reduce the necessity of costly Shuttle emergency flight capabilities.

4.3 Equipment

The preliminary list of major equipment for the defined research objectives has been established based on tentative scientific and operational medicine requirements.

- Human Physiology
  - SLED, Long SLED.
  - Human Centrifuge (radius ∿ 10 m).
  - Rotating Chair.
  - Posture Platform.
  - Ergometer.
  - Respiratory Monitoring System and Gas Analysis.
  - Ultrasound Measuring Devices.
  - Peripheral Blood Pressure Measuring System.
  - Plethysmograph.
  - Ophtalmoscope and Ocular Pressure Measurement Device.
  - EEG, ECG Monitoring Devices.
  - Biochemical Laboratory with centrifuges.
  - Dedicated Medical Data Processing System.
- Medicine (in addition to above)
  - Equipment for testing of invasive treatment (animal testing).
  - Medical care equipment for non-invasive treatment (e.g. initially an improved Shuttle Medical Kit).
  - Hyperbaric chamber.

The diagnostic equipment needed for medical care and crew health check-up is the same one as the equipment for the human physiology research programme.

A major part of the equipment for the Human Physiology research programme will be available as space tested hardware by 1990 through programmes like the ESA Anthrorack and space SLED.
The medical care equipment will continuously be improved and extended as a result of the experiments and tests performed on the Space Station until ultimately a medical care clinic will be built up.

4.4 Space Station Relevance

The primary mission criteria for human physiology research and medicine on a Space Station is the presence of man with a very high crew involvement in the different research activities (Table 4.1).
Secondary mission criteria are:

- mission duration: weeks up to a year, and
- microgravity : $<10^{-3}$ g for some experiments.

An early start of the human physiology research in all subdisciplines is of greatest importance. Only so can the full utilization of the Space Station for the latter part of the 1990's be achieved, once the human adaptation and its limits in the space environment are fully known.

The development of adequate health care and medical treatment facilities will become an essential part of the research activities on a Space Station.

Table 4.1: MISSION CRITERIA FOR HUMAN PHYSIOLOGY AND MEDICINE

MISSION CRITERIA / RESEARCH OBJECTIVE	COSMIC RADIATION	MICRO GRAVITY	VACUUM	CONTROLLED ATMOSPHERE	MISSION DURATION	CREW INVOLVEMENT	INCLINATION & ORBIT	TEST SUBJECTS				TEST PLATFORM		REMARKS
								MICRO-ORGANISMS	PLANTS	ANIMALS	CREW	SPACE STATION	UNMANNED FREE FLYER	
HUMAN PHYSIOLOGY	Con-trol-led	$<10^{-3}$ g	-	X	1week up to a year	very high	Stand. $+57^{0}$, 400km	-	-	X	X	X	-	Radiation level controlled to determination combined effects
MEDICINE	-	$\sim10^{-2}$ g	-	X	weeks	very high	Standard	-	-	X	X	X	-	Gravity level controlled for medical experiments

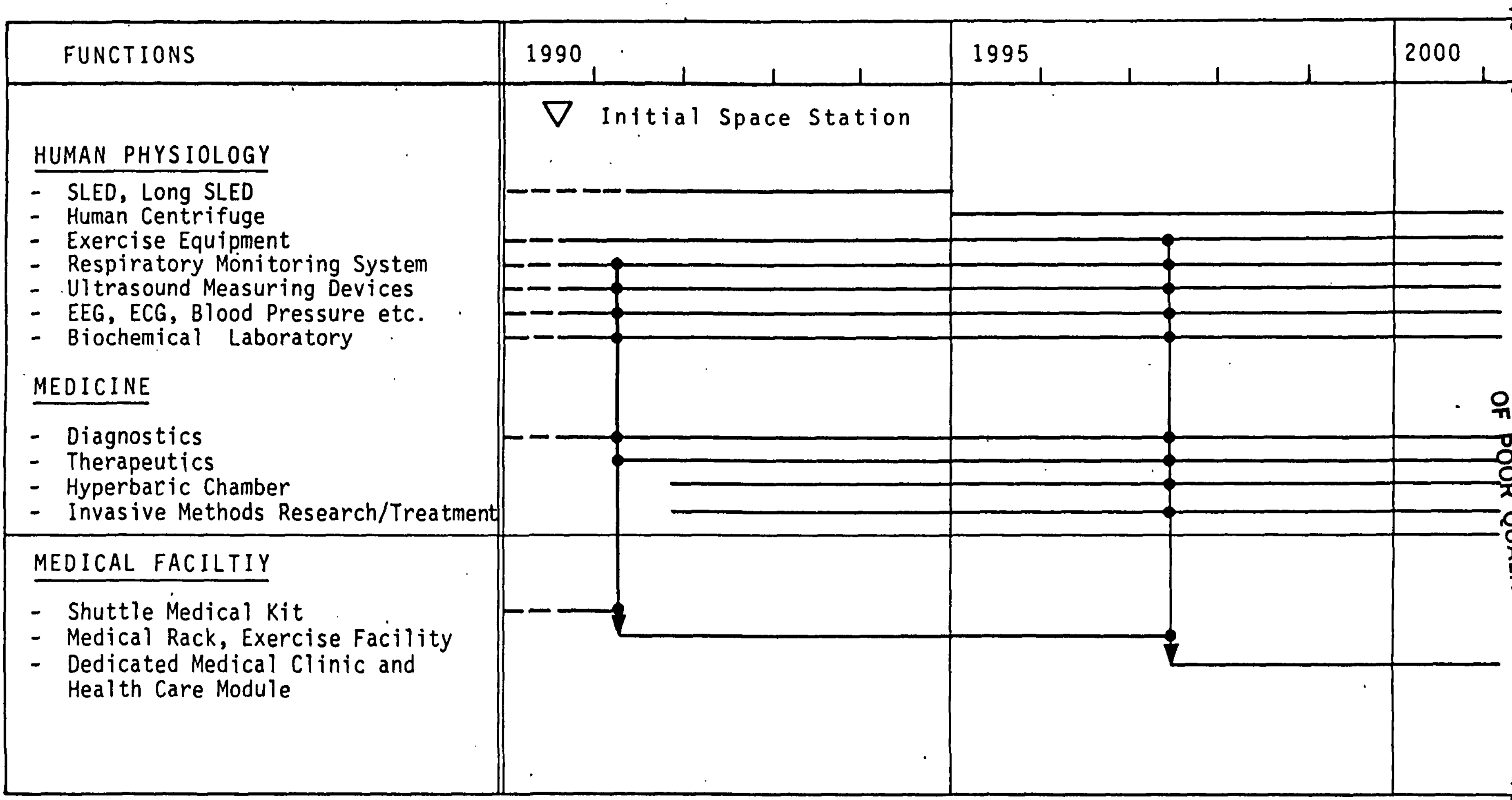
The mission scenario for the Space Station contains Shuttle resupply missions every 60 - 90 days, later the interval might increase to up to 180 days. Between thesese revisits a return capability to ground is not available by other means than through a Shuttle emergency flight which could take 20-30 days to prepare for. An other costly alternative would be a dedicated emergency vehicle for Space Station to ground operations. It is therefore of outermost importance to develop medical diagnostic, therapeutic and treatment procedures and equipment in order to bridge the gap between Shuttle visits and to avoid expensive Shuttle emergency missions as far as possible.

4.5 Mission Implementation

The equipment needed for human physiology research and space medicine are very closely interrelated. A major part of the monitoring and measuring apparatus for the human physiology (e.g. ultrasound measuring devices, EEG, ECG, blood pressure, biochemical laboratory) is also direct applicable as diagnostic instruments for medical treatment. This will allow for a routine use of this equipment in physiology research, and at the same time the equipment is available in case of required medical care. To a large extent this equipment will be tested and used in human physiology research missions with Spacelab during the 1980's (e.g. ESA Anthrorack) (Table 4.2).

One problem to be solved before extensive medical care can be performed on a Space Station is the potential use of invasive methods in microgravity.

Table 4.2: HUMAN PHYSIOLOGY AND MEDICINE TIME PHASING



The expected increased number of crewmembers towards the end of the 1990's will require a dedicated Medical Clinic and Health Care Module. This module could also handle most of the continued human physiology research activities.

For the Initial Space Station, at first during the build up with more frequent Shuttle visits, an improved Shuttle Medical Kit in combination with the diagnostic equipment form the human physiology research programme will be available for medical care. Later on a dedicated Medical Rack with additional therapeutic equipment will be implemented. This will enable a detailed diagnosis to be performed by a crew member with elementary medical training (type paramedics) in direct contact with medical experts on ground before treatment and possible return to ground is initiated. A detailed diagnosis in space should provided the decision criteria for the necessity of a Shuttle emergency mission.

The Medical Rack facility will during the growth of the Space Station and with improved and new therapeutic methods (e.g. some invasive treatment) then expand into the Medical Clinic and Health Care Module as described above. The implementation of such a module would require an astronaut with an adequate medical training.

The implementation of a human centrifuge (diameter 15 - 20 m) is an explicit ambition of the scientific community in order to determine the influence of frequent shifts between microgravity and the 1 g condition. This would enable the final decision as to if artificial gravity for every long missions will be become necessary.

If such a centrifuge can be implemented on a Space Station in the 1990's requires further investigations. Envisaged problems are disturbances in the microgravity environment, and adequate space. The centrifuge is presently proposed as a one man cabin on a rotating arm outside the pressurized modules.

The typical Space Station requirements for Human Physiology and Medicine are based on data from hardware already existing or under development together with estimates from the scientific users community for hardware to be developed specifically for the Space Station (Table 4.3).

Table 4.3 : TYPICAL SPACE STATION REQUIREMENTS FOR HUMAN PHYSIOLOGY AND MEDICINE

RESEARCH OBJECTIVE / SPACE STATION REQUIREMENTS	MISSION DURATION	MICRO-GRAVITY	MASS	VOLUME	POWER	CREW TIME	REMARKS
	DAYS	g	kg	m^3	kW	hrs/d	
HUMAN PHYSIOLOGY	8-60	$<10^{-3}$	25-100	0.1-0.5	0.1-1	0.5 1-2	CONTROLLED RADIATION LEVEL
	60-180		100-300	1-2	0.5-2	0.5 1-2	
	180-365					3-4	
			300-600	2-3	1-3	1-2 3-4	DOUBLE RACK LABORATORY
	30-90	$<10^{-3}$	500	30-40	2	2	LONG SLED
	90-365	$<10^{-3}$	1000 +	500 +	TBD	8-16	HUMAN CENTRIFUGE
MEDICINE	8-60	10^{-2}	25-100	0.1-0.5	0.1-1	1-2	CONTROLLED GRAVITY LEVEL FOR MEDICAL EX-PERIMENTS
			300-600	2-3	1-3	1-2	
MEDICAL FACILITY							
- MEDICAL RACK	90-	-	500-600	2	2-3	as req.	USED AS REQUIRED FOR MEDICAL CARE AND HEALTH CHECK-UPS IN ADDITION TO HUMAN PHYSIOLOGY RESEARCH
- MEDICAL CLINIC MODULE	90-	-	8.000-10.000	60-70	5-7	as req.	

5. CONCLUSIONS

Mission scenarios for the various subdisciplines of life sciences and life support development for Space Station applications have been defined to a level of detail, which will enable the analysis of various architectural options for a Space Station.

The life sciences community has well defined objectives for their activities in the 1990's and in particular the potential use of the Space Station. These objectives provided the basis for the analysis of mission criteria, the experiment time phasing and the determination of typical Space Station requirements for the various life sciences subdisciplines.

The life sciences programme was split into:

- Life Sciences Research (basic; Gravitational Biology, Radiation Biology and Exobiology)
- Human Physiology and Medicine, and
- Life Support Systems.

This enabled a clear requirements definition and a logical build-up of the activities on a Space Station. Furthermore the distinct character of a Space Station subsystem for the Operational Medicine and the Life Support Systems is pronounced by the foreseeable dedicated Medical Clinic and Health Care Module.

For each of the subdisciplines the life sciences community provided detailed equipment lists which supported the elaboration of Space Station requirements for a set of typical payloads.

The strong interest of the Life Sciences Community in the use of a Space Station was documented in a pertinent participation in a German workshop for potential users of a Space Station held during the course of this study. This workshop provided valuable data on the use of a Space Station for life sciences research and life support system development.

6. REFERENCES

1. ESA Technology Research Programme for 1983 and Medium Term Plan for 1984 - 85
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4. H. Bjurstedt: Biology and Medicine in Space,
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5. F. Bonde-Petersen, H. Hinghofer-Szalkay & J. Hordinsky: Microgravity as an Additional Tool for Research in Human Physiology,
ESA BR-09, January 1982.

6. Workshop for Potential Users of Future Space Platforms (Arbeitstreffen potentieller Nutzer künftiger Raumplattformen),
Session: Life Sciences.
DFVLR, Köln-Porz, December 21, 1982.

APPENDIX 1

SUMMARY OF STUDY TASKS AND FINAL REPORT TOPICAL CROSS REFERENCE

SUMMARY OF STUDY TASKS

The study accomplished 3 major objectives:

1. Identified, collected, and analyzed science, applications, commercial, national security, technology development and space operations missions that require or benefit by the availability of a permanently manned space station. The space station attributes and characteristics that will be necessary to satisfy these requirements were identified.
2. Identified alternative space station architectural concepts that would satisfy the user mission requirements.
3. Performed programmatic analyses to define cost and schedule implications of the various architectural options.

Figure A-1 shows the summary task flow that was used to accomplish these objectives.

In Tasks 1.1 thru 1.5, missions were identified, screened, and their needs and benefits analyzed. Mission investigators were assigned to each of the mission classes (science and applications, commercial, technology development, space operations, and national security). In general, these investigators (and their supporting subcontractors) contacted potential users and analyzed available data to characterize potential mission needs. They worked in conjunction with designers and operations analysts to characterize the potential payloads and operational interfaces. In Task 1.6, the missions were allocated to orbits, and were assigned to platforms, free-flyers, or space stations, as appropriate. During Task 1.7, the various missions were integrated into time-phased mission models. The time-phasing took into account available budgetary constraints, prioritization, time sequencing constraints, and transportation availability. A computer program was used to process the integrated time-phased mission model to derive a year-by-year shuttle manifest schedule. The computer program was also used for Task 1.8 to derive the integrated time-phased space station accommodation requirements, i.e., power and thermal demands, berthing requirements, and crew skills. These mission analyses have been reported in Volume 2 of the final report.

Also included in Volume 2 are the results from Task 1.10. In this task, some of the primary commerical opportunities were examined to define the economics of the use of a space station and to define the benefits of doing business on a space station relative to doing it using the shuttle.

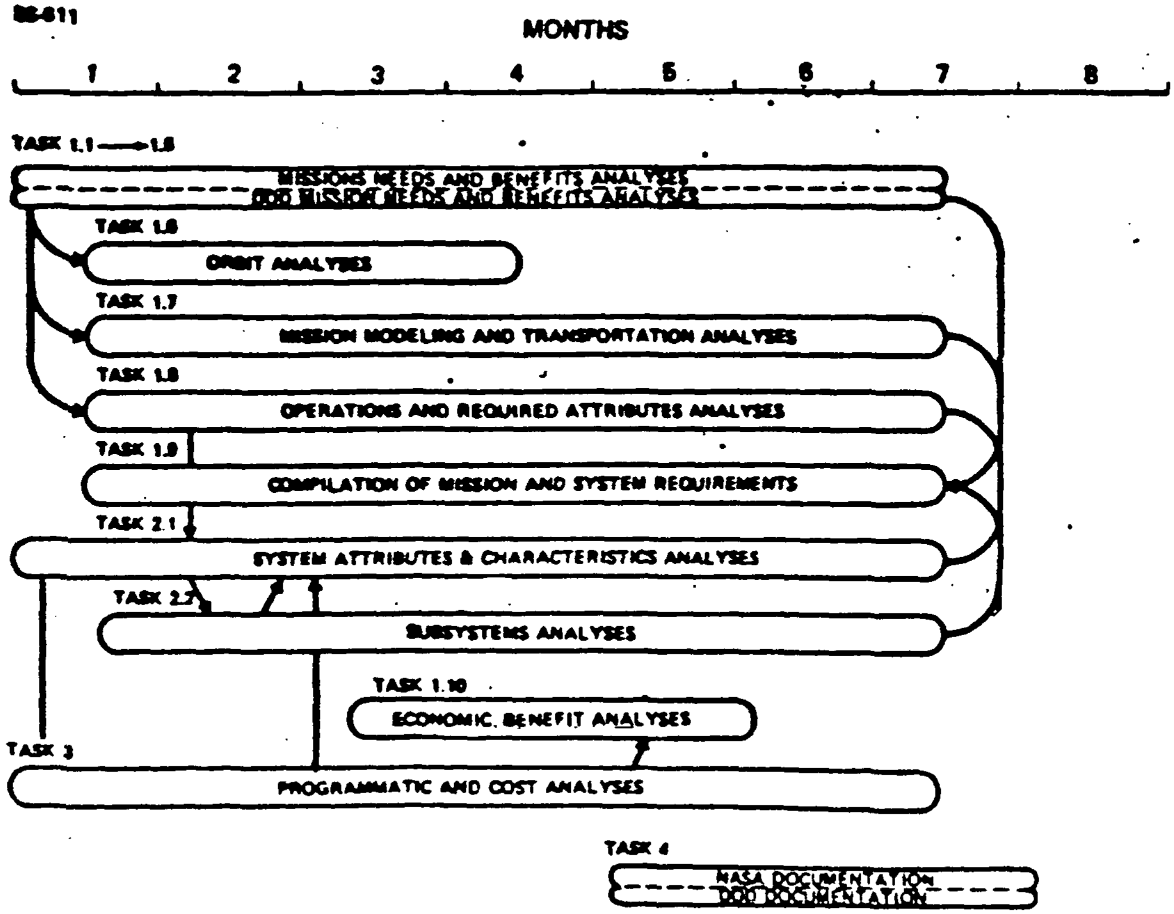

Figure A-1. Summary Diagram Outlines Major Task Traffic

In Task 1.9, mission requirements and space station design requirements were identified. An aggregate of these requirements are reported in Volume 3.

Volume 4 of the final report contains the results from Tasks 2.1, 2.2 and 3. Specifically in Task 2.1, a methodology for defining realistic architectural options was established. This methodology was applied using the requirements defined in the previous tasks. From this, we have created 3 architectural options and have shown some reference space station configuration concepts for each architectural option. Task 2.2 was performed to obtain analysis and trades of some of the principle subsystems, i.e., data management, environmental control and life support, and habitability. Task 3 provides the analyses of programmatics and cost options associated with the concepts derived during the study.

A cross reference guide to enable locating study topics within the volumes and volume sections of the final report is presented in Table A-1.

TABLE A-1

Final Report Topical Cross Reference Guide

Topic	Vol. 1 Exec Summ	Vol. 2 Mission Anal	Vol. 3 Rqm'ts	Vol. 4 Archit	Vol. 5 DoD	Vol. 6 Final Brief	Vol. 7-1 Sci/App Data Book	Vol. 7-2 Commer Data Book	Vol. 7-3 Tech Demo Data Book	Vol. 7-4 Archit Data Book	Vol. 7-5 Mission Data Book
Commercial Missions											
o Communication Satellites	o	3.2.1				o		o			
o Reconfigurable											
o Multibeam											
o Materials Proc.	o	3.2.2		I-1.3.2.3, 1.2.2.1		o		o			
o Semiconductors											
o Biological											
o Glass Fibers											
o Earth Observation		3.2.3									
Industrial Services		3.2.4						o			
o Crew Selection & Training											
o In-Space OPS											
Technology Demo's	o	3.3				o			o		
Space Operation	o	3.4				o					
o Construction											
o Flight Support											
o Servicing											

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Science & Applications Missions											
o Space Environment Missions	o	3.1.2				o	o				
o Astrophysics Missions	o	3.1.3				o	o				
o Earth Environment Missions	o	3.1.4				o	o				
o Life Sciences Missions	o	3.1.5				o	o				
o Materials Science Missions	o	3.1.6					o				
Scenarios of Operational Capabilities o Mission Constrained o Station Constrained o No Space Station	o	4.0, 5.0				o					

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Mission Requirements Summary		5.0									o
o Low Inclination Space Station	o	5.2,5.3	3.2.1	I-1.2.2.4		o					o
o High Inclination Space Station	o	5.2,5.3		I-1.2.2.4		o					o
o Platform only	o	5.4				o					o
o Manifesting o Shuttle o OTV o TMS	o	5.2, 5.3, 5.4				o					o
o Crew Size	o	5.2,5.3 5.4	3.2.1			o					o
o Crew Skills		5.2.5.3 3.1.2.5, 3.1.3.5, 3.1.4.5, 3.1.5.5, 3.2.1.5, 3.2.2.6, 3.2.3 3.3		II-2.2.3							o

TABLE A-1

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Mission Requirements Summary (Continued)											
o Accommodations Reqm'ts	o	2.2 5.2,5.3	3.2.1			o					o
o Power		5.4	I-1.2.1.2, 1.2.2.4 1.2.3.3 1.2.3.4								
o Internal Vol											
o Berthing Ports											
Benefits		6.0									
o Semiconductor Manufacturing	o	6.2				o					o
o Glass Fiber Manufacturing	o	6.3				o					o
o Communications Satellite Assembly	o	6.4				o					o
o Biological Materials Manufacturing	o	6.5				o					o

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Mission Analysis											
o Manifesting Analysis Software	o	2.2				o					o
o Accommodations & Crew Activity Analysis Software	o	2.2				o					o
o Crew Skills											
o Crew Size											
o Berthing Ports											
o Electrical power											
o Internal volume											
Design Requirements											
o Mission Accommodation Reqm'ts		5.0	3.2								
o Interfaces				II-10.0						o	
o Berthing/Docking Port				I-1.3.2.1							
o Hangar		3.3		I-1.3.2.2							

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Architectural Options											
o Architecture Development Methodology	o			I-1.1		o				o	
o Space Station Architectural Options	o			I-1.2		o				o	
Build-up and Growth	o	5.0		I-1.2.3.4, 1.3.1.3, 1.3.2.3, 1.3.3.3							
Data Management											
o Architecture				II-3.2						o	
o In-Flt Checkout				II-3.3						o	
o Space-Ground Integration				II-3.4						o	
o Ground Lab				II-3.5						o	
o Software Devel.				II-3.6						o	
o Hardware Stds				II-3.7						o	
o Software Stds				II-3.8						o	
o Verif/Valid.				II-3.9						o	

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Logistics/Resupply											
o Logistics Module				II-7.1, 7.3,7.4							
o Resupply Reqm'ts				II-7.2							
Environmental Control and Life Support Subsystem				II-5.0						o	
o ECLS Evolution				II-5.2.1, 5.3.2						o	
o Safe Haven Logistics Module				II-5.2.1						o	
o Air Revitalization System				II-5.0,5.3.2						o	
o Water Revitalization System				II-5.0,5.3.2						o	
o Performance and Loads Specification										o	
o Overboard Venting				II-5.2.1,5.2.2						o	
o Architecture				II-5.2.1						o	
o Water Recovery System				II-5.0,5.3.2						o	
o CO_2 Concentration				II-5.0,5.3.2						o	
o Regenerative-Fuel-Cell-Based ECLS				II-5.0,5.2.1, 5.3.2						o	
o Recommendations				II-5.0, 5.3.2						o	
EVA/EMU				II-5.0, 5.2.2						o	

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Communications & Tracking Subsystem			3.2.2.1.11	II-4.0						o	
Manipulator System				II-6.0						o	
Pointing Systems				II-8.0						o	
Thermal Management				II-9.0						o	
Crew				II-2.0							
o Tasks				II-2.2						o	
o Skills		5.2.5.3 3.1.2.5, 3.1.3.5, 3.1.4.5, 3.1.5.5, 3.2.1.5 3.2.2.6, 3.2.3 3.3		II-2.2.3							
o Capabilities				II-2.2.2						o	
o Role Relationships				II-2.3.2						o	
o Accommodations			3.2.2.1.11	II-2.4						o	

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Crew (Continued)											
o Habitability	o		3.2.2.1.11	II-2.0,2.4						o	
o IVA Work Stations				II-2.5.2						o	
o EVA Work Stations				II-2.5.3 II-5.2.2						o	
o Maintenance				II-2.5.4						o	
o Stowage			3.2.2.1.11							o	
o Windows			3.2.2.1.11	II-2.4.1						o	
o Hygiene			3.2.2.1.11	II-2.4.2.4						o	
o Scheduling			3.2.2.1.11	II-2.3.1						o	

APPENDIX 2

KEY TEAM MEMBERS

KEY TEAM MEMBERS

Subject	Boeing Team	Subcontractor Team	
Study Manager	Gordon Woodcock	ADL:	Dr. Peter Glaser
		Battelle:	Kenneth E. Hughes
		ECON:	John Skratt
		ERIM:	Albert Sellman
		Hamilton Standard:	Harlan Brose
		Intermetrics:	John Hanaway
		Life Systems:	Franz Shubert
		MRA:	Col. Richard Randolph (Ret.)
		NBS:	Dr. B. J. Bluth
		RCA:	Dr. Herbert Gurk
		SAI:	Dr. Hugh R. Anderson
Technology Manager	Dr. Richard L. Olson		
Mission Analysis			
Science & Applications	Dr. Harold Liemohn David Tingey (Earth Obs.)	SAI:	Dr. Hugh R. Anderson (Environmental Science)
	Dr. Derek Mahaffey (Mission Integration)		Dr. Peter Hendricks (Meterology/ Oceanography)
	Melvin W. Oleson (Life Sciences)		Dr. Gil Stegen
	Dr. Robert Spiger (Plasma physics, astro-physics, solar physics)		Dr. John Wilson (Life Sciences)
			Dr. Robert Loveless (Integration)
			Dr. Robin Muench
			Dr. Stuart Gorney (Life Sciences)
			Ms. Monica Dussman (Life Sciences)
		ERIM:	Albert Sellman (Earth Obs.)
			Dr. Irvin Sattinger (Earth Obs.)
Commercial	Dr. Harvey Willenberg	RCA:	Dr. Herbert Gurk
			Thaddeus (Ted) Hawkes
		ADL:	Dr. Peter Glaser
		Battelle:	Dr. Kenneth E. Hughes
		MRA:	Col. Richard Randolph (Ret.)
			Robert Pace

KEY TEAM MEMBERS (Cont'd)

Subject	Boeing Team	Subcontractor Team	
Mission Analysis (Cont'd)			
Technology Demonstrations	George Reid Dr. Alan G. Osgood David S. Parkman Steve Robinson Richard Gates Tim Vinopal		
National Defense	Robert S.Y. Yoseph	ERIM:	Mirko Najman
Space Operations	Keith H. Miller		
Architecture and Subsystems			
Architecture & Configurations	John J. Olson Brand Griffin Tim Vinopal David S. Parkman Steve Robinson		
Communications		RCA:	Donald McGiffney
Crew Systems	Keith H. Miller George Reid Dr. Alan G. Osgood	NBS:	Dr. B. J. Bluth
Data Management and Software	Les Holgerson	Intermetrics:	John Hanaway
ECLSS	Keith H. Miller	Ham Std: Life Systems:	Harlan Brose Ross Cushman Al Boehm Ken King Todd Lewis Dr. R. A. Winveen Franz Schubert Dr. Dennis B. Heppner
Operations Analysis	Keith H. Miller George Reid Dr. Alan G. Osgood		
Orbit Analysis	Dani Eder		

KEY TEAM MEMBERS (Cont'd)

Subject	Boeing Team	Subcontractor Team	
Architecture and Subsystems (Cont'd)			
Orbit/Survivability Analysis	Stephen W. Paris Merri Anne Stowe		
C^3I	H. Paul Janes		
Radiation Effects	Dr. William C. Bowman		
Requirements Analysis	Lowell Wiley		
Programmatics & Cost			
Cost Analysis	Ken verGowe	ECON:	Ed Dupnick
Programmatics	Gordon Woodcock		

APPENDIX 3

ACRONYMS AND ABBREVIATIONS

LIST OF ACRONYMS AND ABBREVIATIONS

AAP	Airlock Adapter Plate
AC	Alternating Current
ADM	Adaptive Delta Modulation
AM	Airlock Module
APC	Adaptive Predictive Coders
APSM	Automated Power Systems Management
ACS	Attitude Control System
ARS	Air Revitalization System
ASE	Airborn Support Equipment
BIT	Built in Test
BITE	Built in Test Equipment
CAMS	Continuous Atmosphere Monitoring System
C&D	Controls and Displays
C&W	Caution and Warning
CCA	Communications Carrier Assembly
CCC	Contaminant Control Cartridge
CCTV	Closed Circuit Television
CEI	Critical End Item
CER	Cost Estimating Relationship
CF	Construction Facility
CMG	Control Moment Gyro
CMD	Command
CMDS	Commands
CO_2	Carbon Dioxide
CPU	Computer Processor Units
CRT	Cathode Ray Tube
dB	Decibels
DC	Direct Current
DCM	Display and Control Module
DDT&E	Design, Development, Test, and Evaluation
DOD, DoD	Department of Defense
DT	Docking Tunnel
DM	Docking Module
DMS	Data Management System
DSCS	Defense Satellite Communications System
ECLSS	Environmental Control/Life Support System
EDC	Electrochemical Depolarized CO_2 Concentrator
EEH	EMU Electrical Harness
EIRP	Effective Isotropic Radiated Power
EMI	Electromagnetic Interference
EMU	Extravehicular Mobility Unit
EPS	Electrical Power System
ET	External Tank
EVA	Extravehicular Activity
EVC	EVA Communications System
EVVA	EVA Visor Assembly
FM	Flow Meter
FMEA	Failure Mode and Effects Analysis
ftc	Foot candles
FSF	Flight Support Facility
FSS	Fluid Storage System
GaAs	Gallium Acsenide

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

GN&C	Guidance, Navigation and Control
GEO	Geosynchronous Earth Orbit
GHZ	Gigahertz
GPC	General Payload Computer
GPS	Global Positioning System
GSE	Ground Support Equipment
GSTDN	Ground Satellite Tracking and Data Network
GFE	Government Furnished Equipment
GTV	Ground Test Vehicle
HLL	High Level Language
HLLV	Heavy Lift Launch Vehicle
HM	Habitat Module
HMF	Health Maintenance Facility
HPA	Handling and Positioning Aide
HUT	Hard Upper Torso
Hz	Hertz (cycles per second)
ICD	Interface Control Document
IDB	Insert Drink Bag
IOC	Initial Operating Capability
IR	Infrared
IVA	Intravehicular Activity
JSC	Johnson Space Center
KBPS	Kilo Bits Per Second
KM, Km	Kilometers
KSC	Kennedy Space Center
lbm	Pounds Mass
LCD	Liquid Crystal Display
LCVG	Liquid Cooling and Ventilation Garment
LED	Light Emitting Diode
LEO	Low Earth Orbit
LiOH	Lithium Hydroxide
LM	Logistics Module
LPC	Linear Predictive Coders
LRU	Lowest Replaceable Unit
LSS	Life Support System
LTA	Lower Torso Assembly
LV	Launch Vehicle
lx	Lumens
MBA	Multibeam Antenna
mbps	Megabits per second
MHz	Megahertz
MMU	Manned Maneuvering Unit
MM-Wave	Millimeter wave
MOTV	Manned Orbit Transfer Vehicle
MRWS	Manned Remote Work Station
MSFN	Manned Space Flight Network
N/A	Not Applicable
NBS	National Bureau of Standards
NSA	National Security Agency
N	Newton
NiCd	Nickel Cadmium
NiH_2	Nickle Hydrogen

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

Nm,nm	Nautical miles
N/m^2	Newtons per meter squared
OBS	Operational Bioinstrumentation System
OCS	Onboard Checkout System
OCP	Open Cherrypicker
OMS	Orbital Manuevering System
OTV	Orbital Transfer Vehicle
PCM	Pulse Code Modulation
PCM	Parametric Cost Model
PEP	Power Extension Package
PIDA	Payload Installation and Deployment Apparatus
P/L	Payload
PLSS	Portable Life Support System
PM	Power Module
POM	Proximity Operations Module
ppm	Parts per Million
PRS	Personnel Rescue System
PSID	Pounds per Square Inch Differential
RCS	Reaction Control System
REM	Roentgen Equivalent Man
RF	Radio Frequency
RFI	Radio Frequency Interference
RMS	Remote Manipulator System
RPM	Revolutions Per Minute
RPS	Real-time Photogrammetric System
SAF	Systems Assembly Facility
SAWD	Solid Amine Water Desorbed
SPGaAs	Space Produced Gallium Arsenide
scfm	Standard Cubic Feet per Minute
SCS	Stability and Control System
SCU	Service and Cooling Umbilical
SDV	Shuttle - Derived Vehicle
SDHLV	Shuttle - Derived Heavy Lift Vehicle
SEPS	Solar Electric Propulsion System
SF	Storage Facility
SM	Service Module
SOC	Space Operations Center
SOP	Secondary Oxygen Pack
SRB	Solid Rocket Booster
SRMS	Shuttle Remote Manipulative System
SRU	Shop Replacable Units
SSA	Space Suite Assembly
SSME	Space Shuttle Main Engine
STS	Space Transportation System
SSP	Space Station Prototype
STAR	Shuttle Turnaround Analysis Report
STDN	Spaceflight Tracking and Data Network
STE	Standard Test Equipment
TBD	To Be Determined
TDRSS	Tracing and Data Relay Satellite System
TFU	Theoretical First Unit
TGA	Trace Gas Analyzer

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

TIMES	Thermoelectric Integrated Membrane Evaporation System
TLM	Telemetry
TM	Telemetry
TMS	Teleoperator Maneuvering System
TT	Turntable/Tilttable
TV	Television
UCD	Urine Collection Device
VCD	Vapor Compression Distillation
VDC	Volts Direct Current
VLSI	Very Large Sacle Integrated Circuits
VSS	Versatile Servicing Stage
WBS	Work Breakdown Structure
WMS	Waste Management System