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January 15, 1998
NRA 98-HEDS-01

Research Announcement

Research Opportunities in Space Life Sciences

Advanced Human Support Technology Program

1998

A Research Announcement for the Life Sciences Division

Letters of Intent Due: **March 13, 1998**
Proposals Due: **April 15, 1998**

OMB Approval No. 2700-0042

NASA Research Announcement Soliciting Proposals for Research Opportunities in Space Life Sciences

Advanced Human Support Technology Program

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Life Sciences Division

Office of Life and Microgravity Sciences and Applications
National Aeronautics and Space Administration
Washington, DC 20546-0001

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NASA Research Announcement

Research Opportunities
in
Space Life Sciences

Advanced Human Support
Technology Program

Introduction

This National Aeronautics and Space Administration (NASA) Research Announcement (NRA) solicits proposals to participate in research opportunities in the Advanced Human Support Technology (AHST) Program of the Space Life Sciences Division. This Announcement solicits proposals for research and for development of technologies that will enable humans to more efficiently and effectively live and work in space.

The AHST Program seeks to fund a balance of long-range and maturing technologies, especially those that will have a dramatic impact on reduction of mass, power, volume and crew-time and increased reliability.

In particular, highly innovative proposals based upon cutting-edge technologies and bold, novel approaches, even though they may contain some risk of failure, are sought.

A case in point would be to create advanced technologies and devices that are inspired by biology and/or biological principals. Some existing examples of these have already been established in computational science and sensor technology.

It is NASA's vision that this NRA will further the exploitation of such biological principals to create exciting new technologies with properties inherent in the biological world, i.e., miniature, low power, sensitive and fault tolerant.

In consonance with NASA's mission and the goals of the Human Exploration and Development of Space (HEDS) Strategic Enterprise, research supported by the AHST program of the Life Sciences Division will:

> Prepare to conduct human missions of exploration to planetary and other bodies in the solar system;
>
> Use the environment of space to expand scientific knowledge;
>
> Provide safe and affordable human access to space, establish a human presence in space, and share the human experience of being in space; and
>
> Enable the commercial development of space and share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth.

The specific research and technology development elements of the AHST Program that are included in this Announcement are Space Human Factors Engineering, Advanced Life Support, and Advanced Environmental Monitoring and Control. This Announcement is restricted to the AHST science and technology program elements named above and described in detail in

Appendix A. Potential proposers should read the program and element descriptions that are of interest with care and focus their proposals on the specific research emphases defined in this Announcement.

This Announcement will be updated and issued annually and will be the primary means of obtaining AHST research and technology proposals. In addition, a separate Life Sciences Division Announcement for the Gravitational Biology and Ecology Program and the Biomedical Research and Countermeasures Program is scheduled to be released in mid-1998.

General Information

The following items apply only to this Announcement.

Solicitation Announcement Identifier:	NRA 98-HEDS-01
Number of Proposal Copies Required:	Original + 25 copies
Letters of Intent Due:	March 13, 1998
Proposals Due:	April 15, 1998
Selecting Official:	Director Life Sciences Division Office of Life and Microgravity Sciences and Applications
Additional Programmatic Information:	Program Element Coordinator (indicated in table below) UL/Life Sciences Division NASA Headquarters Washington, DC 20546-0001 Telephone: (202) 358-2530 Fax: (202) 358-4168

Program Element	**Program Element Coordinator**
Space Human Factors Engineering	June Ellison
Advanced Life Support	Guy Fogleman, Ph.D.
Advanced Env. Monitoring & Control	Darrell Jan, Ph.D.
Flight Experiments	Peter R. Ahlf

Types of Proposals Accepted

Proposals submitted in response to this Announcement may be for ground-based research or, if the technology is sufficiently mature, for limited types of space-flight experiments designed for the Shuttle middeck or for the earliest phase of utilization of the International Space Station. Proposals may be for activities lasting up to three years and beginning in FY 1999.

Flight Opportunities

Because of the severe limitations of access to flight opportunities, proposals for flight experiments are very competitive and should be based on solid ground-based research findings.

Proposer Eligibility

Participation in this Announcement is open to all individuals and all categories of domestic and foreign organizations, industry, educational institutions, other nonprofit organizations, NASA laboratories, and other government agencies. Proposals that will enhance or complement the scientific return from research currently being supported by industry or by other government agencies are encouraged.

> ***Note: Non-U.S. proposers should refer to Appendix A, Section VI, Part C for a discussion of the limitations and restrictions affecting foreign proposals.***

Evaluation of Proposals

Proposals will be evaluated by an independent peer-review panel for overall scientific or technical value. Innovativeness, such as leveraging off recent advances in biological technologies, and potential for non-NASA applications will also be considered. Relevance to NASA's programmatic needs and goals and the feasibility of implementation will be evaluated separately by NASA. See Appendix A, Section V for more details on proposal evaluation.

A selection announcement will be made in September-October of 1998, pending budget availability. Funding of selected proposals will begin sometime between October, 1998 and April, 1999.

Proposal Preparation and AHST Program Element Information

Further details concerning the AHST Program and the preparation of proposals in response to this Announcement are included in the attached appendices.

> **Appendix A -** provides technical information about AHST Program elements and other information that is applicable only to this Announcement.
>
> **Appendix B -** contains general guidance for responding to NASA Research Announcements.
>
> **Appendix C -** contains a description of available NASA facilities.
>
> **Appendix D -** contains detailed instructions for proposal preparation and the required application forms for responding to this Announcement.

Submission of Proposals and Letters of Intent

Proposals and Letters of Intent mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

> Information Dynamics, Inc.
> SUBJECT: NASA Life Sciences Research Proposal
> 300 D Street, SW
> Suite 801
> Washington, DC 20024
> phone: (202) 479-2609

Proposals and Letters of Intent hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between the hours of 8:00 AM and 4:30 PM, M-F. The telephone number (202) 479-2609 may be used when required for reference by delivery services.

> ***Note: Information Dynamics, Inc. (IDI) cannot receive deliveries on Saturdays, Sundays, or federal holidays.***

Following receipt of a proposal, IDI will send a postcard to the proposer confirming receipt.

Letters of Intent (only) may also be submitted electronically via e-mail to the following address:

loi@hq.nasa.gov

Selection of Awardees

The government's obligation to make awards is contingent upon the availability of appropriated funds from which payment for award purposes can be made and the receipt of proposals that the government determines are acceptable for award under this NRA.

It is anticipated that there will be approximately 25 awards for proposals submitted in response to this NRA and that each award will average approximately $150,000 for total annual costs, although requests for support may vary from $15,000 to $350,000 per year.

> ***Proposers should note that because the selection process will include an evaluation of the cost-effectiveness of each potential project, proposals that request substantially higher amounts of support may be at a disadvantage if the higher budget request is not adequately justified.***

Your interest and cooperation in participating in this effort are appreciated.

Arnauld E. Nicogossian, M.D.
Associate Administrator for
Life and Microgravity Sciences and Applications

APPENDIX A
NRA 98-HEDS-01

ADVANCED HUMAN SUPPORT TECHNOLOGY PROGRAM

I. Introduction

The Life Sciences Division of the National Aeronautics and Space Administration (NASA) seeks proposals for the Advanced Human Support Technology (AHST) Program in support of the Human Exploration and Development of Space (HEDS) Enterprise. This Announcement solicits scientific and technical proposals to be funded during Fiscal Year 1999, either for new research or for the continuation of research beyond the term specified in a previously funded proposal.

In particular, this Announcement solicits research and technological proposals, based upon sound principles, that are highly innovative even though they may contain some risk of failure. Bold, novel approaches to solving technology needs are particularly encouraged.

A separate Life Sciences Division Announcement for the Gravitational Biology and Ecology Program and the Biomedical Research and Countermeasures Program is scheduled to be released in mid-1998. Other Announcements calling for focused research or utilization of unique resources also may be issued throughout the year. Unsolicited proposals that are programmatically relevant but are received at other times during the year in almost all cases will be held until the next annual review period.

Proposals for research and technology development in areas outside those defined in this Announcement will be rejected or returned to the proposer without review. However, NASA reserves the right to act in the best interests of the Federal Government in the matter of acceptance for evaluation.

II. General Instructions

Demonstration of Overall Benefit to NASA

All proposers responding to this NASA Research Announcement need to quantify the benefit of their work to NASA in terms of minimization of mass, power and crew time utilized, increased system reliability, safety, etc., for present or future missions.

Sharing HEDS Knowledge

One of the stated goals of the Human Exploration and Development of Space (HEDS) Enterprise is "to share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth." Therefore, individuals participating in NASA's Life Sciences Division programs are expected to help foster the development of a scientifically informed and aware public.

Specifically, because the Life Sciences Division programs represent an opportunity for NASA to enhance and broaden public knowledge, understanding, and appreciation of life sciences research and of the value of research in the space environment, all participants in this NRA are strongly encouraged to promote general scientific literacy and public understanding of life sciences, the

space environment, and the Space Life Sciences programs through formal and/or informal education opportunities. Supported investigators will be expected to produce, in collaboration with NASA, a plan for communicating their work to the public.

Proposal Types

Ground-Based Experiments It is expected that the majority of proposals submitted in response to this solicitation will fall into the category of technology development proposals, i.e., proposals to carry out a technical study in an Earth-based laboratory and having a clearly defined set of technical objectives relevant to NASA's mission. Proposals to conduct ground-based research leading to the development of technologies for testing and evaluation during the later phases of the International Space Station utilization (from 2001 onward) are particularly encouraged. If proposals require special Earth-based NASA facilities for their completion, proposers should contact pertinent NASA field centers to arrange for access to the facilities prior to submitting their proposal (see Appendix C of this Announcement).

Space-Flight Experiments Flight experiments will be accommodated on the carrier that is best suited to the execution of each experiment. Proposals are sought to carry out one of two special types of scientific and technical studies in space:

1? **Short-duration** experiments that can be implemented primarily on the Shuttle middeck without the use of major mission resources, or
2? **Long-duration** experiments that can be implemented with the limited resources available on the International Space Station (ISS) during the early assembly phase (1999-2001).

Space studies proposed for the Space Shuttle or ISS are severely constrained by limitations on resources such as weight, power, and crew time and by the availability of flight hardware. Proposals requiring resources beyond the capabilities defined in this Announcement should **not** be submitted at this time. Flight investigations must represent mature studies strongly anchored in previous ground-based research and/or previous flight research (see Section IV of this appendix) and must be thoroughly justified.

A proposal may be multidisciplinary or interdisciplinary, involving combinations of these research and technology development elements; if this is the case, this fact should be stated clearly at the beginning of the proposal. Proposals should include a well-defined development plan that can be accomplished within **three** years or fewer.

Integration with NASA Programs

At an appropriate point in the development of these technologies and after suitable evaluation, the appropriate NASA field center will become increasingly involved in the technology development in order to ensure that requirements for future use are being addressed in the technology development effort. Appropriate points of contact at NASA are listed for each of the AHST Program Elements described in Section III of this appendix.

Proposers are required to include a projection showing the time frame for the anticipated use of their technology in flight systems. This requirement is not meant to favor near-ready technologies over concept-level, high-risk technologies, but rather to stimulate creative, innovative ideas for incorporating new technologies into flight systems as early as possible. In fulfilling this requirement, proposers are encouraged to refer to current Program Plans (see Bibliography, Section VII of this appendix) and to contact appropriate NASA field center personnel.

Use of Human or Animal Research Subjects

NASA has a strong commitment to the ethical treatment of human and animal research subjects. Assurance of compliance with federal regulations regarding human subjects and/or animal care and use is required as part of the proposal submission process. Proposers should refer to the "Special Matters" section in Appendix D of this Announcement.

> ***Note: Review of proposals involving human or animal research subjects may not be undertaken if the required information is not supplied (see Section of this appendix).***

III. Advanced Human Support Technology (AHST) Program

The mission of the Human Exploration and Development of Space (HEDS) Strategic Enterprise is to open the space frontier by exploring, using, and enabling the development of space. In using the space environment, the Enterprise will develop the tools and skills to live and work in space, to take advantage of its unique environment for conducting research in science and engineering, and to generate new technology.

The Advanced Human Support Technology Program contains three Program Elements:

Space Human Factors Engineering
Advanced Life Support
Advanced Environmental Monitoring and Control

> ***Note: It is important that the prospective investigator read the relevant program element sections carefully, as many of the areas of programmatic emphases are different from those appearing in previous Life Sciences Division NASA Research Announcements.***

A. Space Human Factors Engineering

Element Description

The Space Human Factors Engineering (SHFE) element of the Advanced Human Support Technology (AHST) Program is designed to integrate knowledge about human capabilities and system engineering methodologies into spacecraft design, mission planning, and related ground operations. The SHFE element also encourages the development of new processes and procedures; draws on human factors expertise in aeronautics to optimize crew training, automated systems design, proficiency and productivity; and uses relevant analog studies in simulators as well as in extreme and isolated environments. The emphasis in this NRA is on SHFE. The Behavior and Performance element will be addressed in a separate NASA Research Announcement to be released in mid-1998 by the Biomedical Research and Countermeasures Program. Behavior and Performance research activities are oriented toward the human component, both individual and group, of the human-machine interface, psychology, cognitive science, physiology, neurology, human behavior and performance.

The SHFE element is organized around four major goals, each representing a distinct focus. These goals are to:

Expand knowledge of human physical capabilities and limitations in space

Develop cost-effective technologies that support integrating the human and system elements of space flight

Use human factors research results and technology developments in mission planning to increase mission success and crew safety

Make NASA technology available to the private sector for Earth applications

Proposals Sought

Proposals are sought that will dramatically advance the goals of Space Human Factors Engineering (SHFE). In particular, the SHFE element seeks proposals for the development of highly innovative technologies based on cutting-edge, state-of-the-art methods.

Element Emphases for FY 1999

Highest priority in FY 1999 will be given to those **technologies or techniques** from which NASA can derive the earliest possible benefit. To be considered for funding in FY 1999, proposals should focus on one or more of the following areas (it should be noted that these research topics are not given in priority order):

Communication

Interfaces for mission communications among all participants, ground personnel, vehicles, etc., in a multiplicity of modes (audio, video, data, etc.)

Undistorted messages in the presence of delays and limited bandwidth

Multicultural communication technology

Human interaction with information and automation

Interfaces for repair and maintenance procedures

Interfaces with a variety of automated and semiautonomous systems, such as science experiments, vehicle systems, landing controls, etc.

Interfaces with robotic systems

Human-computer interface software capable of recognition of and response to emotion

Experience-on-demand information systems; e.g., just-in-time training

Technology for virtual environment systems

Technology to enhance human visualization of their environment

Data analysis and distribution

Human interfaces for effective and efficient data presentation and analysis

On-line interpretation of data from multiple sensors in various formats, etc.

Design/development/testing/evaluation

Human factors guidelines for tools, facilities, crew aids, fasteners, etc.

Vehicle and work place/operator stations designed for crew size and performance variability while mindful of safety and overall usability

Distribution of tasks between crew members and automation

Safety

Safety analysis for appropriate cautions, warnings, and risk management

Designs to support safe maintenance, both routine and unusual

Safe handling of hazardous materials

Tools and equipment

Uniform, well-designed tool sets for manual and/or gloved (EVA) use

Sufficient tools to support planned and contingency tasks

Training

Training for infrequent tasks (e.g., final Earth landing after an extended mission)

Mission support

Appropriate decomposition of tasks focusing on automated components

"On-line" documentation of procedures

Crew performance

Designs incorporating human reliability data

Flight Experiments

Space-flight missions represent a unique opportunity for researchers to analyze habitability and other human factors issues associated with long-duration missions. Human factors issues need to be researched and resolved in order to better plan future missions to ensure optimal crew productivity and safety. Some basic goals of SHFE flight proposals are:

Begin characterization of the ISS environment from a habitability standpoint

Begin evaluation of crew procedures for resupply inventory management, loose equipment tracking/location, etc.

Perform mental and physical workload measurements on the crew to assess crew interaction with hardware interfaces and to assess adequacy of crew functional responsibilities

NASA Technical Contact

In order for applicants to better understand NASA's scientific and technological needs and to enable more effective transfer of their scientific and technological advances to NASA, it would be of advantage to applicants to explore opportunities to interact with NASA Space Human Factors personnel. The appropriate contact person is:

Ms. June Ellison
Code UL Life Sciences
NASA Headquarters
300 E Street, SW
Washington DC 20546-0001
phone: 202-358-0576
email: jellison@hq.nasa.gov

Supporting Documents

Further information on this element of the AHST Program can be obtained from the following documents (see Bibliography, Section VII of this appendix for details):

Space Human Factors Program Plan (1995)
Space Human Factors: Critical Research & Technology Definition (1996)

These supporting documents can be accessed via the Internet at the following World Wide Web address:

http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

At this address, choose **NRA** or **Research Opportunities**. Under **Program Plans and Requirements Documents**, choose the appropriate Space Human Factors document or **Extravehicular Activity**.

B. Advanced Life Support

Element Description

The Advanced Life Support Element of the AHST Program was initiated to develop advanced regenerative life support systems to support human missions in space. Such missions, including the International Space Station (ISS) and possible future planetary exploration, may last from months to years. Resupply of life support materials is expensive and, in some cases, may become impractical, necessitating greater self-sufficiency of the subsystems used on the mission.

Subsystems must be developed that fully recycle air and water, and recover resources from solid wastes. This may involve the utilization of plants for air, water and solid waste recycling, as well as for food and for the psychological well being of the crew. Systems integration, thermal control and food processing technologies are also important considerations in an Advanced Life Support system.

Proposals Sought

Proposals are sought that will dramatically advance the goals of optimization of mass, power, volume, crew time, and reliability for an Advanced Life Support System. In particular, the mass requirement of the life support system serves as a good aggregate indicator of life support system performance, which is critical in determining the cost of human space flight. Proposers should include a discussion of how their proposed work will impact system mass.

In addition, the Advanced Life Support Element of the AHST Program seeks proposals for the development of highly innovative technologies based on cutting-edge, state-of-the-art methods, especially those that are biologically inspired. For example, development of designer plant/microbe waste products; plants genetically engineered for disease and radiation resistance; and self-diagnosing, self-repairing biomaterials for EVA.

Element Emphases for FY 1999

For FY 1999, the primary emphases of the Advanced Life Support (ALS) Element of the AHST Program will be in the following areas:

- **Systems studies**
- **Solid waste processing/resource recovery from solid wastes**
- **Reduction of power required for plant growth lighting and heat rejection**
- **Food processing technologies, especially those suited for use on ISS**

System Studies Systems analysis, engineering and integration include methods to guide investments in technology, resolve and integrate competing needs, and guide the evolution of complex systems. Systems analysis is particularly important for ALS systems where multiple technologies can perform the same function. Therefore, it is essential that systems analysis and trade-off studies be conducted to support strategic planning and to provide direction for decisions regarding technology development. System modeling and control research should focus on the development of mathematical or laboratory models with particular attention to the application of engineering control theory and provision for model validation, especially for mathematical models.

Extravehicular Activity (EVA)

In addition to the above technologies directed at intravehicular activities, the ALS element also includes activities that address life support problems associated with advanced extravehicular activity (EVA). Specifically, further technology development is needed in the areas of thermal control systems, atmospheric monitoring and control, and integration of these subsystems. Research is needed in certain areas of portable life support system (PLSS) technology to develop simple, reliable, partially and fully regenerable subsystems that can be packaged into easily maintained microclimate control systems comparable in size to the fully expendable system currently in use.

Special emphasis should be placed on technologies which can be made lightweight and low volume so that they may also be used in the EVA portable life support system and as components of *In-Situ* Resource Utilization (ISRU) production plants.

Innovative proposals are particularly encouraged. One such topic is research to adapt the mechanisms that move carbon dioxide from the human body to the task of removing carbon dioxide from the space suit environment, using skin as an analogue for spacesuit material.

Flight Experiments

Knowledge of the effects of microgravity on Life Support Systems is essential for the success of the HEDS Program. A major technology goal of ALS development is to resolve issues of

microgravity performance through research and evaluation in space. Therefore, the program element solicits proposals to examine the gravitational sensitivity of candidate life support processes, components, and subsystems.

NASA Technical Contact

Due to the applied nature of the ALS Program Element, proposals solicited by this Announcement tend primarily to be for technology development and applied, rather than fundamental, research. Research undertaken and technologies developed for ALS tend to find ready application and rapid integration into NASA's ongoing programs.

In order for applicants to better understand NASA's scientific and technological needs and to enable more effective transfer of their scientific and technological advances to NASA, it would be of advantage to applicants to explore opportunities to interact with NASA Advanced Life Support personnel through the Johnson Space Center (JSC). The appropriate Advanced Life Support contact person is:

Dr. Donald Henninger
Mail Code EC3
NASA Johnson Space Center
Houston, TX 77058
phone: 281-483-5034
fax: 281-483-9167
email: dhennin1@ems.jsc.nasa.gov

Proposers may also want to refer to the Advanced Life Support web site for more information:

http://pet.jsc.nasa.gov

Supporting Documents

Further information about the Advanced Life Support program element can be found in the following documents (see Bibliography, Section VII of this appendix for details).

Advanced Life Support Program Plan (1997)
Advanced Life Support Requirements Document (1998)
Advanced Life Support Current Technology Assessment Matrix (1998)
Advanced Technology for Human Support in Space: NRC Report (1997)
EVA Roadmap

These supporting documents can be accessed via the Internet at the following World Wide Web address:

http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

At this address, choose **NRA** or **Research Opportunities**. Under **Program Plans and Requirements Documents**, choose the appropriate Advanced Life Support document or **Extravehicular Activity.**

C. Advanced Environmental Monitoring and Control

Element Description

The Advanced Environmental Monitoring and Control (AEMC) element of the AHST Program develops advanced technologies that monitor the physical environments of both the human compartments and life support systems of current and future space craft and extravehicular activity (EVA) systems, and respond through control systems as appropriate in order to maintain crew health and safety.

The overarching goal for the evolution of a sensing strategy to monitor the health of the space craft environment is to progress from measurements to diagnosis to repair. Long-duration space flights with ever-decreasing support from an Earth link will require a concomitant strategy for measuring the health of the environment as well as a sensing strategy that will allow for self diagnosis and, ultimately, self repair.

Proposals Sought

Proposals are sought for sensors in the areas of water, microbial, and air monitoring, especially those that will dramatically advance the goals of optimization of mass, power, crew time, and reliability while increasing response speed. A highly dense, distributed system of small sensors that is integrated via a local area network and interface with a trend prediction control engine (e.g., a neural net or artificial intelligence) to allow for automated control via feedback and feedforward mechanisms is envisioned.

In addition, the Advanced Environmental Monitoring and Control element of the AHST Program seeks proposals for the development of highly innovative sensor technologies based on cutting-edge, state-of-the-art methods, especially those that are biologically inspired. Some sample topics are: the use of plants and microbes for biohazard detection and response, microbial detection using PCR and DNA-probe techniques, monitoring and control systems that are analogous to living cell homeostasis and response systems, and technologies derived from the convergence of electronics and molecular methods.

Proposers should specifically consider the following characteristics in the development of their technologies:

- lightweight
- miniature
- robust and highly reliable
- have a rapid response time
- consume little power
- require minimal to zero crew time for repair, maintenance, or sample manipulation
- capable of self calibration, data processing, and fault diagnosis
- minimal volume
- minimal or zero consumables
- easily field serviceable
- compatible with microgravity
- produce negligible heat
- produce negligible or zero hazardous waste
- maximize useful information content from sensor outputs

The above list of characteristics is not necessarily comprehensive and is not intended to serve as a limit on proposed solutions. Note that many of these characteristics are similar to those of an

industrial process monitoring and control technology, as opposed to a laboratory analytical device.

Important information regarding target species, both chemical and biological, can be found in the **AEMC Technology Development Requirements Document**, which is available on-line (see below). Information about EVA monitoring needs can be found in the **EVA Roadmap** which is also available on-line (see Supporting Documents, below).

Element Emphases for FY 1999

For FY 1999, the emphasis of the Advanced Environmental Monitoring and Control Element will be primarily on:

- **Environmental sensors for water monitoring**
- **Microbial monitoring using methods based on molecular biology and solid state devices**
- **Technologies for sample acquisition and preparation**

Other proposals will be accepted but will receive lower priority

Proposals may include the development of new technologies as well as the refinement and microminiaturization of currently available sensors. New proposals will have the highest programmatic priority.

Technology Categories

Water Quality Monitors and Sensors
Including sample preparation, if any

Microbiology Monitors and Sensors
Including sample preparation, if any

Food Monitoring Technologies
Monitoring of microbial growth for nutrient content

Air Quality Monitors and Sensors

Control Technologies
Advancements in hardware and software toward optimal, automated, intelligent, controlled responses to monitored conditions, reducing risks to crew health and safety.

Interfaces
Efficient, reliable interfaces between monitoring and control hardware and other subsystems, such as power or thermal control.

Multi-use Capability Technologies that can monitor multiple media (e.g., air and water), or that can easily be modified to do so, have the potential to reduce mass and volume in terms of redundant units, i.e., one unit may serve as a backup for two systems.

It is also recognized that AEMC monitoring technologies may be useful for noninvasive physiological measurements or for EVA, as well as for habitat use. Such multi-use capability will be considered a desirable advantage.

Other related areas:

Research proposals to establish environmental standards for human health will be solicited through the Environmental Health Element of the Biomedical Research and Countermeasures Program described in the Gravitational Biology and Ecology and Biomedical Research and Countermeasures Programs NRA to be released in mid-1998.

Control of specific subsystem processes is included in System Modeling and Control within the ALS Element of the AHST Program described in Section III, Part B of this appendix.

Technologies to Improve Extravehicular Activity (EVA) Garments Astronauts involved in extended EVA require garments that provide optimal protection from the harsh environment of space while affording them maximal range of motion and dexterity for work outside the space craft. Technologies are solicited to improve astronaut survivability following a puncture of a Thermal Micrometeoroid Garment (TMG) and its underlying bladder material. Further details are available in the **EVA Roadmap** (see NASA Supporting Documents, below).

Flight Experiments

Flight experiments should have as their objective the development of technologies for the monitoring and control of environmental parameters including air/water major constituents and trace contaminants, as well as the microbial environment in air, in water, and on surfaces. Initial activities will focus on the evaluation of advanced environmental sensors and control systems that will help to ensure crew health and safety, while imposing a minimal cost in mass and power consumption.

Sensors that monitor liquids such as water, or that make use of liquids in their operation, generally face microgravity effects. For example, analysis of head space (the air space above a liquid sample) constituents, a common technique in ground-based laboratories, is problematic in microgravity.

Space station configurations will be available for testing advanced environmental monitoring technologies onboard.

NASA Technical Contact

Applications to this Announcement are expected to be directed at applied technology (rather than fundamental science) to be incorporated by NASA.

In order for applicants to better understand NASA's scientific and technological needs and to enable more effective transfer of their scientific and technological advances to NASA, it would be of advantage to applicants to explore opportunities to interact with NASA Advanced Environmental Monitoring and Control personnel. The appropriate Advanced Environmental Monitoring and Control contact person is:

Dr. Darrell L. Jan
Code UL Life Sciences

NASA Headquarters
300 E Street, SW
Washington, DC 20546-0001
phone: 202-358-2365
email: djan@hq.nasa.gov

Supporting Documents

Further information on this element of the AHST Program can be obtained from the following documents (see Bibliography, Section VII of this appendix for details):

Advanced Environmental Monitoring and Control Technology Requirements Document (1998)

Advanced Environmental Monitoring and Control Strategic Plan (1996)

EVA Roadmap

These supporting documents can be accessed via the Internet at the following World Wide Web address:

http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm

At this address, choose **NRA** or **Research Opportunities**. Under **Program Plans and Requirements Documents**, choose the appropriate Advanced Environmental Monitoring and Control document, or **Extravehicular Activity (EVA)**.

IV. Flight Experiments

Proposals for space-flight experiments in areas related to the three elements of the Advanced Human Support Technology Program may be submitted in response to this Announcement if they involve either of two special types of studies:

1? **Short-duration** experiments that can be implemented primarily on the Shuttle without the use of major mission resources; or
2? **Long-duration** experiments that can be implemented with the limited resources available on the International Space Station during the early assembly (construction) phase (1999-2001).

Both of these experiment types are highly constrained in a number of ways as described below.

Proposals requiring resources beyond the capabilities defined below should not be submitted in response to this Announcement.

Potential applicants should recognize that, given the limited flight opportunities that are available at present, the flight experiments area is likely to be one of the most competitive arenas within the Space Life Sciences for FY 1999. It is expected that successful flight experiment proposals will represent mature studies strongly anchored in previous or current ground and/or flight research.

Ground-based research may, and often must, represent one component of a flight experiment proposal. However, such research should be limited to activities that are essential for the final development of an experiment for flight and for the completion and publication of the scientific results of the experiment. In such cases, only one (flight) proposal need be submitted. Preparatory ground research designed to define a mature space experiment should be proposed separately and in its own right as part of the ground-based program.

Note that all flight experiments must address one or more of the AHST Program elements and their research emphases as defined in Section III of this appendix. Applicants proposing flight experiments must provide the information required on Form C (see Appendix D).

Flight experiment proposals should emphasize the actual experiment, duration requirements, and experiment conditions. It should be noted that the informed consent of human subjects (if any are used) must be obtained **prior** to carrying out any study in space, and potential proposers should be aware that obtaining such informed consent will involve a uniform process regardless of country of origin of the proposer.

Applicants should note that flight experiments should be proposed as if the actual flight of the experiment will occur in the period 2001-2002. Experiments that cannot be accomplished within this time period should **not** be proposed at this time. Preference will be given to those proposals requesting only one flight to accomplish the proposed research; however, with strong justification, applicants may request multiple flight opportunities.

Once selected, flight investigators and NASA must agree on the duration of the period (nominally one year) following receipt of specimens and data during which their investigation will be completed. At the end of this period, investigators must provide a final report to NASA and should publish the results of their experiments in appropriate peer-reviewed journals. All suitable experimental and reduced data must be submitted to NASA in a form appropriate for archiving in the Space Life Sciences Data Archive, where it will be available to the scientific community.

Finally, potential applicants should be aware that selection for flight is a multi-step process.

1? Following the initial evaluation of flight proposals, a small group of investigators will receive a letter informing them that their experiment has been selected for definition.
2? During the definition phase, NASA will interact with the applicant and determine whether the proposed experiment can actually be carried out on a space mission, and to refine the cost estimates for the space-flight experiment.
3? At the end of the definition phase, NASA will select a smaller group of investigations to be developed for flight. **Normally, full investigator research funding does not begin until the initiation of the development phase.**

Note: All experiments selected for flight are subject to possible deselection in accordance with NASA Life Sciences Division deselection policy (available on the world wide web at:
http://www.hq.nasa.gov/office/olmsa/lifesci/advhuman.htm. ***All experiments are also subject to re-review every three years to determine continued retention.***

A. Short-Duration Flight Experiments

Short-duration experiment proposals submitted in response to this Announcement are restricted to experiments that can be accommodated on the Shuttle in addition to the primary mission. The experiments themselves are usually stand-alone studies that require limited crew training and involvement to execute. It is possible to take advantage of the location in the Shuttle middeck to obtain late pre-flight installation and early post-flight retrieval of materials.

For more information on the shuttle middeck accommodations, please access the web site:

http://www.ksc.nasa.gov/shuttle/technology/sts-newsref/stsover-prep.html#stsover-mpaccom

It is expected that a limited number of flight opportunities will exist for the use of human (crew) subjects and non-human subjects. Note that the number of crew subjects available to support such studies will be limited due to both the late manifesting of middeck experiments and the limited amount of crew time available to support such experiments.

B. Long-Duration Flight Experiments

Limited research opportunities will be available during the construction phase of the International Space Station (ISS). The duration of these opportunities will be longer than the current Shuttle limit of approximately 16 days, but will be constrained in a variety of other ways. Research opportunities will be available during utilization flights when the Shuttle visits the Space Station and during the time period between the utilization flights when the permanent on-board crew will act as experiment operators and, if necessary, as subjects. The duration of microgravity exposure during the 2001-2002 time frame can, in theory, be indefinite with periodic disturbances caused by the U.S. and Russian transportation vehicle docking activities and by construction activities. The primary opportunities to transport scientific equipment, supplies, and samples will be on the utilization flights of the Shuttle; however, modest capabilities for research-related deliveries and sample returns will be available on assembly flights that will take place every 40-90 days.

It is expected that the following resources will be severely constrained throughout the 2001-2002 time period: crew availability for research operations, power, and logistics resupply (both frequency and mass) to and from the Space Station. Refrigerated stowage on the Shuttle for transport of samples will be very limited and, during certain time frames, refrigerated stowage may not be available on the Space Station. Experiments with few and/or simple in-flight activities have the greatest potential for technical feasibility during this time frame.

V. Proposal Evaluation and Awards Selection Process

The following information is specific to this NRA and **supersedes** the information contained in Sections I and J of Appendix B, *Instructions for Responding to NASA Research Announcements.*

The overall review process for each proposal submitted in response to this Announcement will include the following considerations:

Compliance with the general requirements of the Announcement
Intrinsic scientific or technical merit
Feasibility of implementation (not applicable to all proposals)
Relevance to NASA programs
Cost

All proposals must comply with the general requirements of the Announcement. The most important factor in the evaluation is intrinsic scientific or technical merit, followed by feasibility of implementation (if applicable), relevance to NASA programs, and cost.

A. Compliance with NRA

Upon receipt, proposals will be reviewed for compliance with the requirements of this Announcement. This includes:

1? Submission of complete proposals on or before the due date specified in this Announcement (see Section VI, Part F of this appendix).
2 ? Responsiveness to the areas of program element emphasis described in this Announcement (see Section III of this appendix).
3? Submission of a complete proposal not more than 25 pages in length (this applies only to the body of the proposal; see Section 7, Appendix D).
4? Submission of appropriate Institutional Review Board (IRB) and/or Animal Care and Use Committee (ACUC) certification for all proposals using human or animal test subjects (see Special Matters, Appendix D of this Announcement).
5 ? Submission of all other appropriate forms as required by NASA Research Announcements (refer to Checklist for Proposers, Form D, Appendix D).
6? Submission of a budget that is within the guidelines specified in this Announcement and is for a funding period not exceeding three years in duration (see Section VI, Part A of this appendix).
7? Proposals that are revised versions of proposals previously submitted to NASA must be clearly marked as such and must contain an explanation of how the revised proposal has addressed criticisms from previous NASA review (see Section 7, Appendix D).

Note: At NASA's discretion, non-compliant proposals may be withdrawn from the review process and returned to the proposer without further review.

All compliant proposals, both flight and ground, will undergo a three-tiered review process: for scientific or technical merit, for feasibility of implementation (if applicable), and for cost effectiveness and programmatic relevance.

B. Merit Review

The **first review tier** will be a merit review by a panel of scientific and/or technical experts. The number and diversity of experts required will be determined by the response to this NRA and by the variety of disciplines represented in the proposals relevant to the research emphases described in Section III of this appendix. The merit review panel will assign ***a numerical score from 0-100*** based upon the intrinsic scientific or technical merit of the proposal. This numerical score will reflect the consensus of the panel.

The numerical score assigned by this panel ***will not be affected by the cost of the proposed work nor will it reflect the programmatic relevance of the proposed work to NASA***. However, the panel will be asked to include in their critique of each proposal any comments they may have concerning the proposal's budget and relevance to NASA.

Criteria for Merit Review The following five criteria will be used in the determination of the merit score:

1? **Significance:** Does this study address an important problem? If the aims of the application are achieved, how will scientific knowledge or technology be advanced? What will be the effect of these studies on the concepts, methods or products that drive this field?
2? **Approach:** Are the conceptual framework, design, methods, and analyses adequately developed, well integrated, and appropriate to the aims of the project? Is the proposed approach likely to yield the desired results? Does the applicant acknowledge potential problem areas and consider alternative tactics?
3? **Innovation:** Does the project employ novel concepts, approaches or methods? Are the aims original and innovative? Does the project challenge existing paradigms or develop new methodologies or technologies?
4? **Investigator:** Is the investigator appropriately trained and well suited to carry out this work? Is the work proposed appropriate to the experience level of the principal investigator and any co-investigators? Is the evidence of the investigator's productivity satisfactory?
5? **Environment:** Does the scientific environment in which the work will be performed contribute to the probability of success? Do the proposed experiments take advantage of unique features of the scientific environment or employ useful collaborative arrangements? Is there evidence of institutional support?

C. Feasibility of Implementation Review

The **second tier of review** (not applicable to all proposals) will be an evaluation of the feasibility of implementation of the proposed work. This review will be conducted by an engineering and technical review team assembled by NASA, and will evaluate the feasibility of implementing the proposed projects utilizing available flight and/or ground facilities.

D. Evaluation of Programmatic Relevance and Cost

The **third tier of review** will be conducted by NASA program scientists and managers, who will evaluate the programmatic relevance and cost of each proposal. Evaluation of the cost of a proposed effort includes consideration of the realism and reasonableness of the proposed cost and the relationship of the proposed cost to available funds. Programmatic relevance will include an evaluation of how the proposed work may help achieve an appropriate balance of scientific and technical tasks required by critical research issues faced by the AHST program.

E. Development of Selection Recommendation

The information resulting from these three levels of review will in turn be used to prepare a **selection recommendation** developed by NASA program scientists and managers for each of the AHST program elements described in this Announcement. This recommendation will be based on:

1? The numerical score for merit from the peer review panel.
2? The results of the engineering feasibility review (if applicable).
3? The programmatic relevance and cost of each proposal.
4? For renewals, the investigator's publication record and/or other evidence of productivity resulting from the previously-funded NASA work.

This **selection recommendation** will be presented by NASA program scientists and managers to the Life Sciences Management Council, a group of senior scientists in NASA Headquarters' Life Sciences Division. Following acceptance of the plan by the Council, selection for funding will be made by the Director of the Life Sciences Division.

VI. Program Management Information

A. Type of Awards to be Made

Funding increment:	One year at a time
Funding duration:	One to 3 years, depending on proposal requirement, review panel recommendation, and continuing contribution of the activity
Number awarded:	Approximately 25 expected, depending on number received, review panel recommendation, and available funding
Average funding:	$150,000 per year
Funding range:	$15,000 to $350,000 per year

Role of NASA Field Centers

The NASA AHST field center with primary programmatic responsibility will have a primary role in oversight of these awards and will be responsible, with NASA's Life Sciences Division, for annually evaluating their progress and out-year plans.

B. Eligibility

All categories of institutions and scientists are eligible to submit proposals in response to this NRA. Multi-institutional consortium arrangements also are eligible: the applying entity may collaborate with universities, Federal Government laboratories, the private sector, and state and local government laboratories. In all such arrangements, the applying entity is expected to be responsible for administering the project according to the management approach presented in the proposal.

The applying entity must have in place a documented base of ongoing high quality research in science and technology or in those areas of science and engineering clearly relevant to the specific programmatic objectives and research emphases indicated in this Announcement. Present or prior support by NASA of research and/or training in any institution or for any investigator is neither a prerequisite to submission of a proposal nor is it a competing factor in the selection process.

C. Foreign Proposals

Although NASA does not fund proposals from non-U.S. entities, NASA will accept for review foreign proposals that require use of NASA facilities or utilization of NASA-sponsored flight opportunities. Proposals from non-U.S. entities should not include a cost plan.

> ***Note: Non-U.S. proposals and U.S. proposals that include non-U.S. participation must be endorsed in writing by the respective government agency or funding/sponsoring institution in the country from which the non-U.S. participant is proposing. Such written endorsement should indicate that***
>
> ***(1) The proposal merits careful consideration by NASA, and***
> ***(2) If the proposal is selected, sufficient funds will be made available by that country or agency to undertake the activity as proposed.***

All proposals must be typewritten in English. **All non-U.S. proposals will undergo the same evaluation and selection process as those originating in the U.S.** Non-U.S. proposals and U.S. proposals that include non-U.S. participation must follow all other guidelines and requirements described in this NRA. All proposals must be received before the established closing date. Those received after the closing date will be treated in accordance with NASA's provisions for late proposals. Successful and unsuccessful proposers will be contacted directly by the NASA Program Office coordinating this Announcement. Copies of these letters will be sent to the sponsoring government agency.

Should a non-U.S. proposal or a U.S. proposal with non-U.S. participation be selected, NASA's Space Flight Division (Mail Code: IH) will arrange with the non-U.S. sponsoring agency for the proposed participation on a no-exchange-of-funds basis, in which NASA and the non-U.S. sponsoring agency will each bear the cost of discharging its respective responsibilities. Depending on the nature and extent of the proposed cooperation, these arrangements may entail a letter of notification by NASA and/or an exchange of letters between NASA and the sponsoring government agency.

> ***Note: U.S. Co-Investigators who are collaborating on a non-U.S. proposal must submit a <u>separate</u> proposal to the peer review process that references the non-U.S. proposal and details the work that is to be done by the U.S. Co-I. This proposal must contain all the material any other U.S. proposal is expected to contain, including a detailed budget for the work to be conducted in the U.S.***

D. Program Reporting

Annual Reporting Investigators will be expected to provide NASA with annual summary information. This information will consist primarily of:

an abstract
bibliographic list
copies of publications
a statement of progress

This information may be made available to the scientific community and will be used to assess the strength of the Division's programs. It will also serve as the basis for determining the degree

of progress of the project. Note that although this publication will be made available to the general scientific community, it is not a substitute for traditional scientific reporting in journals and elsewhere.

Final Report It is expected that final results will be submitted to a peer-reviewed journal no later than approximately one year following the funding period.

Implementation Plan Investigators will be required to submit an implementation plan one year prior to the project end date. This plan will describe the process by which the results of the project will be implemented into a NASA program. Since construction of this plan will likely require one or more visits to NASA field centers, **appropriate travel funds should be accounted for in the proposal** (see Section E, Other Considerations, this appendix).

Flight Experiment Reports Investigators selected to carry out space-flight experiments must also provide NASA with two special reports:

(1) A "quick-look" report of preliminary flight results that is due one month after the space flight takes place, and

(2) A final report containing all data and information on the flight study is due approximately one year after all required data/materials are provided by NASA to the investigator. At this time, all of the data must also be provided to NASA for placement in the Life Sciences Data Archive; data in this archive will be made available to the scientific and technical community.

Additional information will be required of investigators at the time of their annual funding renewal.

E. Other Considerations

Travel The proposal must include travel funds for the following:

Annual Principal Investigator meeting

Visits to NASA field centers (as many as necessary)

- Presentation at professional society meeting

Resident Research Associates Intramural investigators who plan to request Resident Research Associate (RRA) postdoctoral fellows supported by the NASA-NRC program should include this in their list of personnel and budget.

F. Deadlines

Letters of Intent To facilitate proposal processing, potential principal investigators are requested to confirm plans to submit a proposal responding to this Announcement by sending a ***letter of intent to propose***, which is not binding, by ***March 13, 1998.*** The letter of intent, which should be no more than two pages, should contain:

The names, addresses, and telephone numbers of a single principal investigator and all co-investigators

A descriptive title of the research or technical proposal

A brief summary describing the proposed research and clearly indicating the AHST program element(s) defined in this Announcement that is/are most relevant to the proposal

The major participating institutions

Up to six (6) key words that best describe the research area of the pending proposal

Letters of Intent to propose may be submitted through the U.S. Postal Service or commercial delivery services in the same manner as proposals (described below). In addition, letters of intent (only) may be submitted electronically via e-mail to the following address:

loi@hq.nasa.gov

Proposals An original signed proposal, plus twenty-five (25) complete copies of that proposal and a 3.5-inch computer disk (containing an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address and the complete project title and abstract, as provided on Form B) in either Macintosh or IBM (or clone) format ***must be received by April 15, 1998.***

Proposals and Letters of Intent mailed through the U.S. Postal Service by express, first class, registered, or certified mail are to be sent to the following address:

Information Dynamics, Inc.
SUBJECT: NASA Life Sciences Research Proposal
300 D Street, SW
Suite 801
Washington, DC 20024

Proposals and Letters of Intent hand delivered or sent by commercial delivery or courier services are to be delivered to the above address between the hours of 8:00 AM and 4:30 PM. The telephone number (202) 479-2609 may be used when required for reference by delivery services.

Note that Information Dynamics, Inc. (IDI) cannot receive deliveries on Saturdays, Sundays, or federal holidays.

G. Proposal Schedule

The following schedule is planned for the acquisition of investigations under this Announcement:

Letter of Intent to Propose Due	March 13, 1998
Proposal Due	April 15, 1998
Selection Announcement	September - October, 1998
Initial Funding Available	October 1998 - April 1999

VII. Bibliography

For information on obtaining documents, refer to note at end of Bibliography

1. **National Aeronautics and Space Administration Strategic Plan (1998)** NASA, Washington, DC **http://www.hq.nasa.gov/office/nsp/**

2. **NASA's Enterprise for the Human Exploration and Development of Space: The Strategic Plan**. **(1996)**. NASA, Washington, DC **http://www.osf.hq.nasa.gov/heds/hedsplan.html**

3. **Advanced Technology for Human Support in Space (1997).** Report of the National Research Council (NRC) Committee on Advanced Technology for Human Support in Space, Aeronautics and Space Engineering Board (ASEB). National Academy Press, Washington DC (ISBN 0-309-05744-2; 1997) **http://www.nap.edu**

4. **NASA Series of Discipline Science/Technology Plans and Requirements Documents** produced by the program elements of the Advanced Human Support Technologies Program in the Life Sciences Division. NASA,Washington, DC

   a ? **Advanced Life Support Program Plan (1997).**
   b ? **Advanced Life Support Program Requirements (1998)**.
   c ? **Space Human Factors Program Plan (1995)**.
   d ? **Space Human Factors: Critical Research & Technology Definition (1996)**.
   e ? **Advanced Environmental Monitoring and Control Strategic Plan (1996).**
   f ? **Advanced Environmental Monitoring and Control Program: Technology Development Requirements (1998)**.

   Available at: http://peer1.idi.usra.edu/peer_review/prog/prog.html

5. National Aeronautics and Space Administration, Life Sciences Division, Washington, DC 20546. Cumulative bibliographies of publications resulting from research supported by the Division.

   a. **Space Human Factors Publications: 1980-1990 (1991)**. K.J. Dickson (Ed.). NASA Contractor Report 4351. *(NTIS # N9120620 - $22.00)*
   b. **Publications of the NASA Controlled Ecological Life Support System (CELSS) Program: 1989-1992 (1994)**. J.V. Powers (Ed.). NASA Contractor Report 4603. (*NTIS #N9430122 - $17.50)*

6. **A Strategy for Space Biology and Medical Science for the 1980s and 1990s.** National Academy of Sciences. National Research Council. Committee on Space Biology and Medicine. Jay M. Goldberg, Committee Chairperson. 1987. Washington, DC: National Academy Press. *(NTIS #N8924024 - $46.50)*

7. **Assessment of Programs in Space Biology and Medicine.** National Academy of Sciences. National Research Council. Committee on Space Biology and Medicine. 1991. Washington, DC: National Academy Press. *(NTIS #N9313327 - $19.50)*

8. **Exploring the Living Universe: A Strategy for Space Life Sciences.** National Aeronautics and Space Administration Advisory Council. Life Sciences Strategic Planning Study Committee. Frederick C. Robbins, Committee Chairperson. 1988. Washington, DC: National Aeronautics and Space Administration.

9. **Space Biology and Medicine: Volume II, Life Support and Habitability.** F.M. Sulzman and A.M. Genin (Eds.). 1994. Washington, DC: American Institute of Aeronautics and Astronautics.

10. **Space Physiology and Medicine, 3rd ed.** A. Nicogossian, C. Huntoon, and S. Pool (Eds.). 1994. Philadelphia, PA: Lea & Febiger.

11. **Strategic Considerations for Support of Humans in Space and Moon/Mars Exploration Missions.** National Aeronautics and Space Administration Advisory Council. Aerospace Medicine Advisory Council. 1992. Washington, DC: National Aeronautics and Space Administration.

12. **Spaceline**. An on-line bibliographic database, is available for searching for references to publications about space life sciences research.
Phone: (301) 295-2482 Email: SPACELINE@mx3.usuhs.mil
http://spaceline.usuhs.mil **http://lgm.nlm.nih.gov** (MEDLINE)

13. **Space Life Sciences Data Archive (LSDA).** An on-line database containing descriptions and results of completed NASA-sponsored flight experiments.
Phone: (281) 483-7876 Email: lsda@semail.jsc.nasa.gov
http://lsda.jsc.nasa.gov

Obtaining documents

Many of the documents cited here may be ordered through your library or through the National Technical Information Service (NTIS). Documents available through NTIS are accompanied by their NTIS order number and price. To order a document through NTIS, call 1-800-553-6847. You may also send e-mail to **orders@ntis.fedworld.gov** or access the NTIS web site at **http://www.ntis.gov**. If you are unable to locate a document through this means, please call (202) 358-4180 and leave a detailed message and your return phone number.

APPENDIX B
NRA 98-HEDS-01

INSTRUCTIONS FOR RESPONDING TO NASA RESEARCH ANNOUNCEMENTS

(JANUARY 1997)

A. General.

(1) Proposals received in response to a NASA Research Announcement (NRA) will be used only for evaluation purposes. NASA does not allow a proposal, the contents of which are not available without restriction from another source, or any unique ideas submitted in response to an NRA to be used as the basis of a solicitation or in negotiation with other organizations, nor is a pre-award synopsis published for individual proposals.

(2) A solicited proposal that results in a NASA award becomes part of the record of that transaction and may be available to the public on specific request; however, information or material that NASA and the awardee mutually agree to be of a privileged nature will be held in confidence to the extent permitted by law, including the Freedom of Information Act.

(3) NRA's contain programmatic information and certain requirements which apply only to proposals prepared in response to that particular announcement. These instructions contain the general proposal preparation information which applies to responses to all NRAs.

(4) A contract, grant, cooperative agreement, or other agreement may be used to accomplish an effort funded in response to an NRA. NASA will determine the appropriate instrument. Contracts resulting from NRA's are subject to the Federal Acquisition Regulation and the NASA FAR Supplement. Any resultant grants or cooperative agreements will be awarded and administered in accordance with the NASA Grant and Cooperative Agreement Handbook (NPG 5800.1).

(5) NASA does not have mandatory forms or formats for responses to NRA's; however, it is requested that proposals conform to the guidelines in these instructions. NASA may accept proposals without discussion; hence, proposals should initially be as complete as possible and be submitted on the proposers' most favorable terms.

(6) To be considered for award, a submission must, at a minimum, present a specific project within the areas delineated by the NRA; contain sufficient technical and cost information to permit a meaningful evaluation; be signed by an official authorized to legally bind the submitting organization; not merely offer to perform standard services or to just provide computer facilities or services; and not significantly duplicate a more specific current or pending NASA solicitation.

B. NRA-Specific Items. Several proposal submission items appear in the NRA itself: the unique NRA identifier; when to submit proposals; where to send proposals; number of copies required; and sources for more information. Items included in these instructions may be supplemented by the NRA.

C. Proposal Content. The following information is needed to permit consideration in an objective manner. NRAs will generally specify topics for which additional information or

greater detail is desirable. Each proposal copy shall contain all submitted material, including a copy of the transmittal letter if it contains substantive information.

(1) *Transmittal Letter or Prefatory Material.*

(i) The legal name and address of the organization and specific division or campus identification if part of a larger organization;

(ii) A brief, scientifically valid project title intelligible to a scientifically literate reader and suitable for use in the public press;

(iii) Type of organization: e.g., profit, nonprofit, educational, small business, minority, women-owned, etc.;

(iv) Name and telephone number of the principal investigator and business personnel who may be contacted during evaluation or negotiation;

(v) Identification of other organizations that are currently evaluating a proposal for the same efforts;

(vi) Identification of the NRA, by number and title, to which the proposal is responding;

(vii) Dollar amount requested, desired starting date, and duration of project;

(viii) Date of submission; and

(ix) Signature of a responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization (unless the signature appears on the proposal itself).

(2) *Restriction on Use and Disclosure of Proposal Information.* Information contained in proposals is used for evaluation purposes only. Offerors or quoters should, in order to maximize protection of trade secrets or other information that is confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting an appropriate identification in the notice. In any event, information contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

Notice

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other

agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(3) *Abstract*. Include a concise (200-300 word if not otherwise specified in the NRA) abstract describing the objective and the method of approach.

(4) *Project Description.*

(i) The main body of the proposal shall be a detailed statement of the work to be undertaken and should include objectives and expected significance; relation to the present state of knowledge; and relation to previous work done on the project and to related work in progress elsewhere. The statement should outline the plan of work, including the broad design of experiments to be undertaken and a description of experimental methods and procedures. The project description should address the evaluation factors in these instructions and any specific factors in the NRA. Any substantial collaboration with individuals not referred to in the budget or use of consultants should be described. Subcontracting significant portions of a research project is discouraged.

(ii) When it is expected that the effort will require more than one year, the proposal should cover the complete project to the extent that it can be reasonably anticipated. Principal emphasis should be on the first year of work, and the description should distinguish clearly between the first year's work and work planned for subsequent years.

(5) *Management Approach.* For large or complex efforts involving interactions among numerous individuals or other organizations, plans for distribution of responsibilities and arrangements for ensuring a coordinated effort should be described.

(6) *Personnel*. The principal investigator is responsible for supervision of the work and participates in the conduct of the research regardless of whether or not compensated under the award. A short biographical sketch of the principal investigator, a list of principal publications and any exceptional qualifications should be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(7) *Facilities and Equipment.*

(i) Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use. Include evidence of its availability and the cognizant Government points
of contact.

(ii) Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible

alternative. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for research and non-research purposes should be explained.

(8) *Proposed Costs.*

(i) Proposals should contain cost and technical parts in one volume: do not use separate "confidential" salary pages. As applicable, include separate cost estimates for salaries and wages; fringe benefits; equipment; expendable materials and supplies; services; domestic and foreign travel; ADP expenses; publication or page charges; consultants; subcontracts; other miscellaneous identifiable direct costs; and indirect costs. List salaries and wages in appropriate organizational categories (e.g., principal investigator, other scientific and engineering professionals, graduate students, research assistants, and technicians and other non-professional personnel). Estimate all staffing data in terms of staff-months or fractions of full-time.

(ii) Explanatory notes should accompany the cost proposal to provide identification and estimated cost of major capital equipment items to be acquired; purpose and estimated number and lengths of trips planned; basis for indirect cost computation (including date of most recent negotiation and cognizant agency); and clarification of other items in the cost proposal that are not self-evident. List estimated expenses as yearly requirements by major
work phases.

(iii) Allowable costs are governed by FAR Part 31 and the NASA FAR Supplement Part 1831 (and OMB Circulars A-21 for educational institutions and A-122 for nonprofit organizations).

(9) *Security*. Proposals should not contain security classified material. If the research requires access to or may generate security classified information, the submitter will be required to comply with Government security regulations.

(10) *Current Support.* For other current projects being conducted by the principal investigator, provide title of project, sponsoring agency, and ending date.

(11) *Special Matters*.

(i) Include any required statements of environmental impact of the research, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

(ii) Proposers should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

D. Renewal Proposals.

(1) Renewal proposals for existing awards will be considered in the same manner as proposals for new endeavors. A renewal proposal should not repeat all of the information that was in the original proposal. The renewal proposal should refer to its predecessor, update the parts that are no longer current, and indicate what elements of the research are expected to be covered during the period for which support is desired. A description of any

significant findings since the most recent progress report should be included. The renewal proposal should treat, in reasonable detail, the plans for the next period, contain a cost estimate, and otherwise adhere to these instructions.

(2) NASA may renew an effort either through amendment of an existing contract or by a new award.

E. Length. Unless otherwise specified in the NRA, effort should be made to keep proposals as brief as possible, concentrating on substantive material. Few proposals need exceed 15-20 pages. Necessary detailed information, such as reprints, should be included as attachments. A complete set of attachments is necessary for each copy of the proposal. As proposals are not returned, avoid use of "one-of-a-kind" attachments.

F. Joint Proposals.

(1) Where multiple organizations are involved, the proposal may be submitted by only one of them. It should clearly describe the role to be played by the other organizations and indicate the legal and managerial arrangements contemplated. In other instances, simultaneous submission of related proposals from each organization might be appropriate, in which case parallel awards would be made.

(2) Where a project of a cooperative nature with NASA is contemplated, describe the contributions expected from any participating NASA investigator and agency facilities or equipment which may be required. The proposal must be confined only to that which the proposing organization can commit itself. "Joint" proposals which specify the internal arrangements NASA will actually make are not acceptable as a means of establishing an agency commitment.

G. Late Proposals. A proposal or modification received after the date or dates specified in an NRA may be considered if doing so is in the best interests of the Government.

H. Withdrawal. Proposals may be withdrawn by the proposer at any time before award. Offerors are requested to notify NASA if the proposal is funded by another organization or of other changed circumstances which dictate termination of evaluation.

I. Evaluation Factors.

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its relevance to NASA's objectives, intrinsic merit, and cost.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission.

(3) Evaluation of its intrinsic merit includes the consideration of the following factors of equal importance:

(i) Overall scientific or technical merit of the proposal or unique and innovative methods, approaches, or concepts demonstrated by the proposal.

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combinations of these which are integral factors for achieving the proposal objectives.

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives.

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort may include the realism and reasonableness of the proposed cost and available funds.

J. Evaluation Techniques. Selection decisions will be made following peer and/or scientific review of the proposals. Several evaluation techniques are regularly used within NASA. In all cases proposals are subject to scientific review by discipline specialists in the area of the proposal. Some proposals are reviewed entirely in-house, others are evaluated by a combination of in-house and selected external reviewers, while yet others are subject to the full external peer review technique (with due regard for conflict-of-interest and protection of proposal information), such as by mail or through assembled panels. The final decisions are made by a NASA selecting official. A proposal which is scientifically and programmatically meritorious, but not selected for award during its initial review, may be included in subsequent reviews unless the proposer requests otherwise.

K. Selection for Award.

(1) When a proposal is not selected for award, the proposer will be notified. NASA will explain generally why the proposal was not selected. Proposers desiring additional information may contact the selecting official who will arrange a debriefing.

(2) When a proposal is selected for award, negotiation and award will be handled by the procurement office in the funding installation. The proposal is used as the basis for negotiation. The contracting officer may request certain business data and may forward a model award instrument and other information pertinent to negotiation.

L. Cancellation of NRA. NASA reserves the right to make no awards under this NRA and to cancel this NRA. NASA assumes no liability for canceling the NRA or for anyone's failure to receive actual notice of cancellation.

APPENDIX C
NRA 98-HEDS-01

Advanced Human Support Technology
Space Life Sciences
Ground Facilities and Flight Hardware

Introduction

This appendix provides a list of ***potentially available*** ground facilities and flight hardware that may support research and technology development for the Advanced Human Support Technology Program. Proposers to this NASA Research Announcement who wish to use these facilities or hardware must contact NASA and coordinate such use ***before submission of their proposal.***

Proposals that depend upon the availability of NASA ground facilities or flight hardware for the successful completion of their work must include ***at the time of submission*** a signed letter from the facility manager indicating that the required facility or hardware is available for use to accomplish this work and is compatible with the goals of the proposal.

Table 1. Potentially Available Ground Facilities and Flight Hardware

Ground Facilities and Flight Hardware	***Ground***	***Flight***	***Flight***
		Short Duration	***Long Duration***
Advanced Life Support Systems Integrated Test Bed	X		
Chemical Sensor Test Facility (CSTF)	X		
Space Human Factors Facility at JSC	X		
Biological Research in Canisters (BRIC)		X	X
Petri Dish Fixation Unit (PDFU)		X	X
KSC Gaseous Nitrogen (GN_2) Freezer		X	X
KSC Plant Growth Facility (PGF)		X	
KSC Plant Growth Unit (PGU)		X	
Microgravity Plant Nutrient Experiment (MPNE)		X	
Data Loggers		X	X
Astrocultureô Plant Growth Unit		X	X
Plant Generic BioProcessing Apparatus (PGBA)		X	X
Biomass Production System (BPS) Plant Growth Unit		X	X

Ground Facility: Advanced Life Support Systems Integrated Test Bed

Description

The **Advanced Life Support Systems Integrated Test Bed (ALS Systems Integration Test Bed)** at the NASA **Johnson Space Center** is a multichamber facility specifically configured for conducting long-duration testing of large-scale integrated life support systems with human test subjects in a closed, confined environment. The test bed will be constructed in two stages—a three-chamber configuration and a five-chamber configuration—which will support integrated testing of air revitalization, water recovery, food production, waste processing, and thermal control systems with human interaction. Additionally, the test bed will support a host of scientific studies associated with long-term crew confinement within the multichamber facility. The test bed in its three-chamber configuration is anticipated to become operational in 2001.

For further information, contact Mr. Terry O. Tri at the Johnson Space Center, telephone: (281) 483-9234.

Ground Facility: Chemical Sensor Test Facility

Description

The **Chemical Sensor Test Facility (CSTF)** at the NASA **Jet Propulsion Laboratory** houses apparatus specifically configured for testing gas phase chemical sensors. Up to five major gas constituents can be mixed, with the mixture ratios being changeable in real-time via computer control. The system can be used to provide controlled mixtures of the target gas for sensor evaluation, or to create specialized atmospheric mixtures at desired temperature and humidity as a background for sensing of trace gases. The CSTF has been used to provide realistic flow conditions for *in situ* sensors. Some aqueous phase sensor test apparatus is also available.

For further information, contact Dr. Gerald Voecks at the Jet Propulsion Laboratory, telephone: (818) 354-6645.

Ground Facility: Space Human Factors Facilities

Description

These labs are managed by the Flight Crew Support Division, located at the Johnson Space Center and consist of the Graphics Research and Analysis Facility (GRAF) and the Anthropometry and Biomechanics Facility (ABF).

The **Graphics Research and Analysis Facility** has systems for computer modeling of humans and environments, providing anthropometric, kinematic and visibility analyses of humans working in 1-g, zero-g, or partial-g. GRAF has access to strength and size databases and a physically-based system for computer modeling illumination for camera/eye vision with the ability to empirically collect luminance and illuminance data. It also has a large collection of models of the Shuttle, Spacelab, Spacehab, and Space Station modules in which to perform this integrated analysis of humans working in space both EVA and IVA.

The **Anthropometry and Biomechanics Facility** collects and analyzes strength, force, and motion data in the lab, in the Weightless Environment Test Facility (WETF), and in the KC-135 zero-g aircraft. Equipment includes Lido dynamometers, Ariel Motion Analysis Systems, and waterproofed and KC-135-qualified force plates. The ABL personnel are experienced in collecting data from suited subjects, as well as on the Precision Air Bearing Floor.

For further information, please contact Dr. Francis Mount at the Johnson Space Center. telephone: (281) 483-3723.

Flight Hardware: Biological Research in Canisters (BRIC)

BIOLOGICAL RESEARCH IN CANISTERS - 100 (BRIC-100)

Dimensions: 114.3 X 381 mm
Power Requirement: None
Weight: 4.4 lb.

The BRIC-100 canister is an anodized-aluminum cylinder with threaded lids on each end. This canister provides containment and structural support for the specimen support hardware and specimens. The outside dimensions of the BRIC-100 canisters are 114.3 mm OD X 381 mm long. The size of the BRIC-100 canister allows it to accommodate standard laboratory 100 mm Petri plates.

The BRIC-100 canisters have lids which allow passive gas exchange of O_2 and CO_2 through a semipermeable membrane. The bottom and top lids of each canister have twenty-five 0.5 mm holes and a Teflon membrane (pore size 0.5 µm). Two septa are located in the lid to allow gas sampling. Underneath this lid, the semipermeable membrane is attached and supported by an anodized-aluminum ring. The ring and membrane assembly are supported by five stainless steel

screws. If gas exchange is not required, the semipermeable membrane and capture ring can be replaced by an aluminum capture plate to provide a closed experimental environment.

The hardware inside the canister consists of nine (9) polycarbonate 100 mm Petri plates held in place by a Petri dish cage insert. The insert is manufactured from 304 stainless steel and contains glide rivets made from acetal. The rack provides both vibration isolation and airspace between each Petri dish.

The BRIC-100 canisters are flown in sets of three; a standard middeck locker can accommodate up to six (6) BRIC-100 canisters. This hardware was flown aboard STS-64, STS-70 and STS-77.

BIOLOGICAL RESEARCH IN CANISTERS - 100VC (BRIC-100VC)

Dimensions: 36 OD X 16.5 mm
Power Requirement: None
Weight: 2.7 lb.

The BRIC-100VC canister is an anodized-aluminum cylinder. The lid of the canister uses a toggle switch and O-ring assembly which allows quick sealing and removal of the lid. Quick disconnect valves are also present on the top lid and bottom of the canisters to allow for gas purge. The bottom of the canister has sufficient storage space for passive temperature and relative humidity recorders, also referred to as data loggers (see section entitled “Data Loggers”).

The BRIC-100VC canister provides containment and structural support for the specimen support hardware and specimens. The outside dimensions of the BRIC-100VC canisters are 114.3 mm OD X 159 mm long. The size of the BRIC-100VC canister allows them to accommodate standard 100 mm laboratory Petri plates. The BRIC-100VC canisters are completely sealed to allow for a controlled experimental environment.

The top and bottom lids of the BRIC-100VC canister each have a quick disconnect valve. Using these valves, a specific atmosphere can be sealed inside the canister, therefore providing control of the experimental conditions.

The BRIC-100VC canisters are flown in sets of nine (9), and a standard middeck locker can accommodate up to eighteen (18) canisters. The BRIC-100VC canisters were flown aboard STS-78 in June 1996 and were launched on STS-81 in January 1997 for a four month mission aboard the Russian space station Mir.

BIOLOGICAL RESEARCH IN CANISTERS - 60 (BRIC-60)

Dimensions: 26 OD X 32 mm
Power Requirement: None
Weight: 1.9 lb.

The BRIC-60 canister is an anodized-aluminum, 82 mm diameter cylinder with an upper and lower chamber. There are four pressure relief holes in each chamber to meet the rapid depressurization

requirements of the Space Shuttle and are designed to maintain a light-tight environment inside the canister chambers. This canister will fit inside the Life Sciences Laboratory Equipment (LSLE) gaseous nitrogen (GN_2) freezer.

Twelve 60 mm Petri dishes (total of 24 per canister) or thirteen (13) Teflon tubes (total of 26 per canister) for growing seedlings can be placed inside each canister chamber. Lithium hydroxide and Purafil have been flown inside these canisters for specimens which produce carbon dioxide (CO_2) and ethylene, respectively.

Up to five canisters can be flown at ambient middeck conditions in a standard middeck locker. If the LSLE GN_2 freezer is utilized for freezing, the flight configuration is two (2) canisters and one (1) GN_2 freezer per middeck locker. The BRIC-60 canisters have supported six Space Shuttle experiments: one Growth Hormone Concentration and Distribution (GHCD) experiment, and five Biological Research in Canister payloads (BRIC-01/BRIC-03/BRIC-06/BRIC-09/BRIC-10).

BRIC-LIGHT EMITTING DIODE (BRIC-LED)

Dimensions: 18 X 9 X 9.5 mm
Power Requirement: 10 W
Weight: 4 lb

The Biological Research In Canisters-Light Emitting Diode (BRIC-LED) is an anodized-aluminum container which provides one level of containment to its contents. A complement set of hardware, the Petri Dish Fixation Unit (PDFU), rests inside the BRIC-LED. The PDFU is a specialized holder for a standard 60 mm Petri dish which delivers fixative to the sample within the Petri dish. Each BRIC-LED can house six (6) PDFUs. Light Emitting Diodes (LEDs) placed inside the canister deliver a specified light intensity to each Petri dish location within the canister. The lid of each BRIC-LED is secured using ten screws, and includes a silicon gasket to provide containment between the lid and the base. Six holes are present in the lid of the BRIC-LED for insertion of a PDFU "actuator" attachment which allows fixation of the specimens. Each of the holes is sealed using a silicone septum. An interface box provides power to the canisters, using the Orbiter as its power source.

The lid of each BRIC-LED houses a circuit board which contains red surface mount LEDs (6 per BRIC) for specimen illumination; switches (6 per BRIC) for controlling on/off status of red LEDs; and green surface mount LEDs (6 per BRIC) for verification of the on/off status of the red LEDs. Each red LED is located on the bottom of the circuit board, with a corresponding green LED located on top of the lid. The green LEDs provide the crew with a method of verifying red LED illumination/operations. Each red LED provides a wavelength of 640-660 nm red light to the samples located inside the canister via a Pyrex light pipe (the light pipe is a component of the PDFU). The switches are located on the top of the circuit board to switch the LEDs on or off at the appropriate time. An additional orange LED is located on top of the circuit board to indicate that power is being properly supplied to the canister's circuitry.

The BRIC-LEDs remain unpowered at launch, after which time their power supply is connected to Orbiter power for the duration of the mission. Following connection to the Orbiter power supply,

Flight Hardware: Biological Research in Canisters (BRIC) (continued)

the BRIC-LED is automatically powered up. At specific times, the surface mount LEDs which provide light treatments to each PDFU are depressed to initiate the experiment.

The BRIC-LED Stowage Tray is used to house the BRIC-LED canisters and power distribution box. The tray is a single stowage tray, and was designed to the dimensions of a standard single stowage tray. The tray is made of anodized aluminum and contains a power connector to allow Orbiter power to be connected to the locker before flight. The tray can also feature an enclosed fan to prevent samples from reaching extreme temperatures. The BRIC-LED canister and stowage tray were flown on STS-87 as part of the Collaborative Ukrainian Experiment (CUE).

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: Petri Dish Fixation Unit (PDFU)

PETRI DISH FIXATION UNIT (PDFU)

Dimensions: 8.5 X 7.5 X 2.5 mm
Power Requirement: None
Weight: 0.30 lb

The Petri Dish Fixation Unit (PDFU) is a complement set of hardware which interfaces with the BRIC-LED. Six (6) PDFUs are contained within each BRIC-LED.

The major components of each PDFU include the following items:
- a chamber for the 60 mm Petri dish;
- a chamber for fixative storage;
- a piston for forcing the fixative into the specimen chamber; and
- a light rod to channel the illumination provided by the red LEDs.

Each PDFU provides two levels of containment to the fixative, which is loaded into the fixative chamber.

Each PDFU consists of a body of polycarbonate which is milled to house the above mentioned chambers. The specimen chamber houses the bottom half of a standard off-the-shelf 60 mm Petri dish. The top half of the 60 mm dish is not needed to house the specimen since the top of

the assembly (e.g., the PDFU cover and manifold) acts as a cover. A set of three O-rings provides a seal between the PDFU cover and the polycarbonate body. The fixative chamber and the specimen chamber are separated by a check valve to prevent unwanted/early fixation of the specimens.

Flight Hardware: Petri Dish Fixation Unit (PDFU) (continued)

An additional feature of the PDFU is a light rod which directs the light from each red LED on the BRIC-LED's canister's circuit board into the PDFU specimen chamber. This glass light rod is constructed of Pyrex and is sealed into the dish using epoxy.
The inside of the PDFUs have sufficient storage for a passive temperature recorder (substituted for a specimen), or data logger. A PDFU which contains a data logger does not contain any fixative.

The PDFU was flown to support the Collaborative Ukrainian Experiment on STS-87.

ACTUATOR TOOL

The Actuator Tool is designed to provide easy fixation of specimens in the Petri Dish Fixation Unit (PDFU). The tool consists of a handle and an advancing body. A stainless steel rod is enclosed in polyethylene to prevent any exposure to sharp edges, and is loaded into the advancing body of the tool.

When fixation is required, the tool is unstowed and a rod is removed from a stowage bag. The rod is then inserted into the inner body of the tool. The actuator tool is then attached to the septum hole in the BRIC-LED lid. The tool is rotated by a quarter turn, which temporarily attaches to the lid of the BRIC-LED. The crew member squeezes the handles, thereby advancing the rod into the BRIC-LED lid and into the PDFU. In order to maintain the appropriate levels of containment in the BRIC-LED and PDFU, the actuator rod is not removed from the PDFU until after fixation. The silicone septum in the lid of the canister provides a seal around the rod when it rests in the BRIC-LED.

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: KSC Gaseous Nitrogen (GN_2) Freezer

KENNEDY SPACE CENTER GASEOUS NITROGEN (GN_2) FREEZER

Dimensions: 116 OD X 52 X 39 mm
Power Requirement: None
Weight: 23.7 lb.

The Kennedy Space Center Gaseous Nitrogen (GN_2) Freezer uses similar technology as the LSLE freezer which has flown regularly on the Space Shuttle and the Mir Space Station. The major differences are that the GN_2 Freezer can hold samples at a temperature of -196C for 21 days; the freezer is stored in a double, rather than single, locker; and insulation material has been added to the vacuum chamber.

Flight Hardware: KSC Gaseous Nitrogen (GN_2) Freezer (continued)

The aluminum outer tank of the freezer houses an internal tank containing the CAB-O-SIL absorbent material used to hold the gaseous nitrogen. The CAB-O-SIL, manufactured by the Cabot Corporation, is a hydrophilic fumed silica whose surface has been rendered hydrophobic by treatment with a silicone fluid. The CAB-O-SIL is insulated with a combination foil, molecular sieve and palladin oxide getter. The insulation material is sealed between the outside tank and the inner tank. The gaseous nitrogen is held in the absorbent material by a vacuum and the insulation material. The freezer has a valve which ensures the integrity of the vacuum container. The sample area inside the internal tank can hold up to four canisters 6" long and 3.7" in diameter.

The freezer charging process begins approximately 96 hours before launch by filling the freezer with liquid nitrogen. The charging process continues over a period of 48 hours until the absorbent material is completely saturated. The freezer is drained of liquid nitrogen approximately one hour before turnover of the payload for installation into the Orbiter. The freezer is installed in the vertical position in the Orbiter middeck.

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: KSC Plant Growth Facility (PGF)

PLANT GROWTH FACILITY (PGF)

Dimensions: 411 X 226 X 483 mm
Power Requirement: 115 W
Weight: 65 lb.

The Plant Growth Facility (PGF) replaces a standard SSP middeck locker. The PGF's first flight was aboard STS-87 in support of the Collaborative Ukrainian Experiment (CUE).

The PGF is composed of the following subsystems: Control and Data Management System (CDMS), Fluorescent Light Module (FLM), Atmospheric Control Module (ACM), Plant Growth Chambers (PGC), Support Structure Assembly (SSA), and the Generic External Shell (GES).

The CDMS provides stand-alone control of the PGF during the entire experiment cycle from ground preparation, through launch, on-orbit operations, landing and post-flight recovery. The system consists of a computer, signal conditioning module, and power module.

The CDMS computer provides stand-alone control of the PGF, making it a fully automatic facility not requiring continuous supervision. The CDMS computer interfaces allow crew interaction on-orbit through the PGF front panel, and user interaction during experiment preparation and ground processing via the Ground Support Equipment (GSE) laptop computer.

Flight Hardware: KSC Plant Growth Facility (PGF) (continued)

The CDMS computer provides the following functions in support of PGF operation: Data acquisition and environmental control based on real-time multi-tasking software; Stand-alone control of the PGF via on-board experiment protocols; Crew Interface via display, keys and status LEDs on the PGF front panel and menu-driven software; and Experiment protocol development via communication through an RS-232 serial port and software residing on the GSE laptop computer. A lithium battery provides backup power to the computer clock in the event the 28V supply is interrupted.

The CDMS Signal Conditioning Module (SCM) provides the electrical and data interface between the PGF sensor signals and the CDMS computer. The SCM consists of a single custom printed circuit board with connecting wiring to the CDMS computer and each of the sensor devices. The SCM provides sensor power and sensor signal conditioning (filtering and gain control).

The Plant Growth Chambers (PGC) for the PGF are a new design, though they are based on the current Plant Growth Units' (PGU) PGCs. This hardware is used for the CHROMEX series of payloads.

The PGC subsystem consists of a base, lid, mesh filter, gas sampling port, and a humidity/temperature sensor. The base is molded polysulphone, and the lid is transparent polycarbonate. The PGC air filters are located along the sides of the PGC lid and are held in place by a sealed frame. The air filters allow the ACM airflow through the PGC while maintaining the water-tight environment within the PGC. The PGC interfaces for the filter-lid, lid-base, and the sensor are liquid-tight seals to prevent the loss of nutrient solution or water.

The PGF Support Structure Assembly (SSA) consists of the SSA tray, slide rails, and front panel. The CDMS, FLM, ACM and PGCs are located on the SSA tray. The slide rail system allows the SSA tray to be hard-mounted to the Generic External Shell (GES) and provides slide-out access to the PGF for ground handling. The front panel, which contains the PGF main power switch, LCD display and four button keypad, is hinged to allow the SSA tray to slide out from the GES. A component cooling loop is provided to the subsystems mounted on the SSA.

Current design of the Generic External Shell (GES) is identical to current SSP lockers, except it is fabricated from aluminum instead of Kevlar®. The GES is designed to be a generic housing for many different middeck experiments and allows the mounting of the payload contents using the slide rail system.

The Power Module (PM) of the CDMS subsystem provides conditioned power to the electrical elements of the PGF derived from the Orbiter 28 VDC supply or from the PGF battery backup system. The PM provides the following functions: regulated and unregulated DC power from

the Orbiter supply; +28 VDC unregulated with EMI Filtering; +28, +24, ±12, and +5 VDC with In-rush current limiting and EMI filtering; and control of a cabin air cooling fan via thermostats and air flow sensors.

The PGF Fluorescent Light Module (FLM) provides a source of light for plant growth. The FLM provides a light intensity of 220 ± 20% mmol/m^2/s^2 and the output spectrum is in the 400 - 700 nanometer wavelength to provide the plants with the maximum photosynthetically active radiation (PAR). The FLM is mounted next to the Plant Growth Chambers (PGC) to provide a uniform diffuse source of light on plants in the chambers.

Flight Hardware: KSC Plant Growth Facility (PGF) (continued)

The FLM is composed of the following components: outer housing and reflector chamber; two fluorescent bulbs; DC electronic ballasts; line filter and TTL compatible switch; Spectralon reflective liner; DC boxer fans; and thermal cutoff switch. The FLM will operate from the 28 VDC power bus with a TTL compatible power On/Off switch. The input power passes through a high performance DC power filter before being applied to the power switch, thermal cutoff switch, and then to the DC electronic ballasts which provide high frequency (40 kHz) power to the fluorescent bulbs. Each bulb is powered separately from its own electronic ballast. Four irradiance level sensors will monitor the output of the bulb array.

The Atmospheric Control Module (ACM) provides air flow to the PGC, individual PGC air flow measurement, water vapor control, heat control, CO_2 control, ethylene removal, organic control, and purgeability.

The PGC conditions are measured and controlled through a series of sensors (CO_2 , temperature, humidity), a thermoelectric cooler (TEC), and filters (ethylene, organics, CO_2, water vapor). Temperature and humidity sensors are located within each PGC and within the ACM loop.

The temperature within the PGCs is controlled by a TEC located in the ACM loop. The average PGC temperature is compared with the programmed setpoint. If a PGC temperature change is required, the ACM loop temperature and humidity are evaluated to determine whether the TEC operation can be modified without creating condensation within the ACM loop. If required, the ACM loop can purge low-humidity Orbiter cabin air into the loop to reduce humidity and thus allow the TEC to cool to a lower temperature.

Humidity, CO_2, ethylene and organic contaminants are controlled through a system of filters built-into the ACM loop. The following table shows the filter bed composition for each filtration requirement.

Filter Requirement	Filtration Method
ethylene	potassium permanganate
organics/dust	activated charcoal/mesh
CO_2	lithium hydroxide
water vapor	Nafion® tube

The ethylene, organic, and CO_2 filters are passive and are accessible during inflight operations if change out is required. The Nafion® tube is an active humidity control system and is controlled by the average PGC relative humidity.

KENNEDY SPACE CENTER FIXATION TUBE (KFT)

Dimensions: 37.5 X 3 mm
Power Requirement: None
Weight: 0.54 lbs

The Kennedy Space Center Fixation Tube (KFT) is designed to collect plant samples during flight and chemically fix the plant samples while providing three levels of containment for the chemical fixative during stowage and operations. The KFT will be used to fix two types of plants: *Brassica*

Flight Hardware: KSC Plant Growth Facility (PGF) (continued)

rapa for the BSTIC and BPAC experiments and soybean for the SOYPAT experiment. The KFT is comprised of six main parts: the main tube where fixative is loaded preflight; the plant tube which will be used to keep the plant in place during flight; the expansion plug; the top plug; the base plug; and the plunger. To fix a plant sample, the sample is placed into the plant tube. A plunger handle is used to push the expansion plug into the fixative, which in turn forces the fixative through an opening at the bottom of the plant tube. A total of 45 KFTs will be flown to support CUE.

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: KSC Plant Growth Unit (PGU)

PLANT GROWTH UNIT (PGU)

Dimensions: 411 X 226 X 483 mm
Power Requirement: 28 VDC
Weight: 67 lbs

The Plant Growth Unit (PGU) is a self-contained unit designed to house six Plant Growth Chambers (PGCs) and occupy the same amount of space as one middeck locker. The PGU supports whole plant growth by providing acceptable environmental conditions for normal plant growth. The PGU can be configured with six PGCs or five PGCs plus the Atmospheric Exchange System (AES). The current units have flown on a total of nine space flight missions. These units have been the workhorse for Space Shuttle whole plant research.

The PGU houses the plant chambers and all experiment controls. Lamps, heaters, and fans are located within the PGU to provide temperature and lighting control. The PGU also contains displays which are located on the PGU control panel and a Data Acquisition System (DAS). An electronic data subsystem internally controls all PGU operations such as recording data on tape,

day/night cycling of the lamps, and fan speed regulation. The PGU is composed of the subsystems discussed below.

The PGU weighs approximately 67 pounds. Attachment to the Orbiter middeck is achieved by the PGU's unique adapter plate. The top-hinged aluminum front door closes off the front of the PGU with openings to permit cooling air to enter the PGU from the middeck environment.

The PGU requires 28 VDC electrical power for operation of the electronic circuits, tape recorder, lamps, fan and heater. Power is supplied by the Orbiter through an SSP-provided cable connected to a DC utility outlet panel. The power cable is routed from the front panel of the PGU to the appropriate MUP panel location. The power usage is 81.2 W during a day cycle and 47.6 W during a night cycle. Every 15 minutes an additional 19.6 W is used for two seconds due to tape

Flight Hardware: KSC Plant Growth Unit (PGU) (continued)

recorder spikes. When externally provided power is interrupted, the PGU uses a non-rechargeable battery pack to operate only the data acquisition electronics and tape recorder. The lamps, fan and heater do not operate on internal battery power in order to conserve power. The PGU power switch must remain in the "ON" position. Cycling the PGU power switch resets the PGU internal clock, which complicates postflight data analysis. No damage occurs when power connections are mated or demated in this configuration.

Temperature is controlled by heat from three PGU lamps and one 20 W strip heater as well as the flow of middeck cabin air through the PGU. Temperature within each PGC is measured by a thermistor or temperature probe. The correct temperature for the PGU is maintained by comparing the control system set point temperature of 24 degrees C with the average of the two temperatures measured in PGC chambers three and six. The difference between the set point temperature and the average temperature is used by the control electronics to regulate the speed of the two cooling fans which circulate cabin air through the PGU. To maintain the desired temperature when the lamps are switched off, the strip heater is activated, and the fans continue to run. The temperature settings must be above cabin air temperature to be controllable. The temperatures of the six PGCs and the ambient temperature are measured every 15 minutes and automatically recorded on the data tape as well as monitored and recorded once a day by a crew member.

Lamps are located within the interior of the PGU to simulate a day and night cycle (16 hrs on, 8 hrs off). The PGU lighting system consists of a bank of three fluorescent lamps containing Duratest Vitalite phosphor lenses, a reflector, an aluminum housing, and associated circuitry. Each lamp has a very low internal pressure and is covered entirely by a Teflon sleeve to ensure that no free glass can escape if the lamps break.

The PGU Data Acquisition System (DAS) contains an analog multiplexer, a sample-and-hold circuit, and record control circuits. Data formatting circuits arrange digitized temperature and light status signals into a serial form along with a digital word for experiment time in days, hours, and minutes. The data block is assembled and processed into the recorder every 15 minutes during the mission. Analog data from the PGU are automatically recorded on a tape recorder.

The Plant Growth Chambers (PGC) are the experiment containers for the PGU. Each PGC consists of a Teflon-coated anodized-aluminum base and Lexan cover secured to the base by four

screws. A thermistor is inserted in the center of each base. Two septum ports are used, in conjunction with the AES, to flow filtered cabin air through the PGC when required.

The Atmospheric Exchange System (AES) replaces one of six standard PGCs in the PGU and circulates filtered cabin air through four of the PGCs with the fifth PGC serving as a control parameter with no air flow. The AES is composed of a small instrument pump, filter, air distribution manifold, tubing and connectors, control circuitry, and display panel. The AES uses DC power from the PGU, which is powered off Orbiter DC power. A DC/DC converter steps down the input voltage from 28 V to 12 V. The AES also contains an AES alarm circuit that is triggered when there is inadequate flow through the AES or low voltage to the primary AES circuit.

The AES filter cartridge contains absorbents within a stainless steel tube. The cartridge passively regulates CO_2 by flowing the air stream over a lithium hydroxide (LiOH) bed. Some air can bypass this bed via the bypass tube, where no CO_2 is removed. The desired flow split, and therefore the desired CO_2 concentration, is obtained by installing a variable restriction orifice in the

Flight Hardware: KSC Plant Growth Unit (PGU) (continued)

bypass line. The total air stream then passes through a trace contaminant control bed consisting of Zeolite, activated carbon, and Purafil. Porous metal discs are used for bed retention and separation, with the inlet disc providing dust filtration.

The AES pump contains a small DC motor that drives a mounted piston. There are two one-way flapper valves that open and close alternately to provide airflow at a rate of 0 to 20 liters per hour. The AES manifold and distribution tubing carries the filtered air from the pump to the manifold which divides the air stream into four equal parts before it flows into the four PGCs.

PLANT GROWTH MEDIA

Nitex Sleeve/Oasis Foam Nutrient System Plantlet roots are placed in a Nitex mesh sleeve that is subsequently inserted into slots in Oasis foam. The Oasis foam is saturated with Hoagland's solution to provide water and plant nutrients. This configuration supports good plant growth and provides for easy removal of whole, intact plants with minimal damage to the roots.

Agar Tube/ Oasis Foam Nutrient System Plants or imbibed seeds are grown in agar-filled polycarbonate centrifuge tubes, which are inserted into an Oasis foam block for structural support. Water may be added to the Oasis foam to reduce agar drying.

Agar Bag Nutrient System Imbibed seeds are placed in pipette filters which in turn are attached to the top of rectangular polypropylene bags filled with agar. The agar in the plastic bags may be stratified with different nutrients to support optimal plant feeding at different growth periods.

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: Microgravity Plant Nutrient Experiment (MPNE)

MICROGRAVITY PLANT NUTRIENT EXPERIMENT (MPNE)

Dimensions: 411 X 226 X 483 mm
Power Requirement: 28 VDC
Weight: 54 lbs

Hardware developed for the Microgravity Plant Nutrient Experiment (MPNE) is configured for insertion into one standard SSP middeck locker. This hardware includes a Plant Enclosure, fluid system, light bank, Command and Data Management System (CDMS), power converter, instrumentation, fans, and Payload Container. This payload operates with 28 VDC Orbiter power.

Flight Hardware: Microgravity Plant Nutrient Experiment (MPNE) (continued)

Current planning includes flying this payload in early 1998 with wheat plants as a technology demonstration for future space flight.

The MPNE Plant Enclosure houses the plant tubes, plants, and fluid circuit. It is constructed from Lexan with a wall between the plants and the balance of the fluid circuit. Liquids and solids associated with the plants and fluid circuit are confined within one portion of the enclosure box, while the balance of the fluid circuit and a video camera are enclosed on the other side.

Active cooling is not provided for the plants in this enclosure. Plants were specifically selected to be grown in the expected environment of 80-100% relative humidity (RH) and 15-35 degree C temperatures. RH and temperature inside the enclosure is monitored by sensors and mission data is archived by the CDMS. The humidity is kept at 80% RH by circulating cabin air into the Plant Enclosure to remove excess moisture.

Fluid used in the MPNE is a plant nutrient solution made of potable water and salts. The nutrient solution is a non-hazardous fluid as evaluated by JSC Toxicology.

The fluid system includes a Water Availability Sensor (WAS) and Water Delivery System (WDS) to manipulate the plant nutrient solution. The WAS is an infrared detector and source connected to an electronics package that senses the quantity of water or plant nutrient solution on the surface of the plant tube. The WDS supplies the solution to the tube and is controlled by the CDMS from WAS input.

The fluid circuit contains and manages the plant nutrient solution for the plant tubes. The plant nutrient solution and plant solids are contained inside the circuit tubing and components. The Fluid Reservoir is enclosed in a Lexan box with a gas permeable membrane to create one level of containment. Powered components (motors, fans, Water Availability Sensor, lights) inside the payload could fail if contacted by nutrient solution. These components are powered by direct current (DC) and are inherently safe from causing damage to the payload.

The MPNE Light Bank of Light Emitting Diodes (LED) provides 100-250 μmol/m2/s of light at 660 nm and 470 nm to the Plant Enclosure. The light bank is an integral part of the Plant Enclosure.

The MPNE Command and Data Management Subsystem (CDMS) is based on the STD bus architecture. The CDMS contains seven computer board modules including a CPU board, Analog to Digital converter board and Flash Memory board. The CDMS controls the operation of the fluid system, lighting system and fan activation. All data from the components, lights, fans, and sensors are archived by the CPU board into non-volatile memory.

The 100 W MPNE Power Converter pair supports the payload electrical system. A triple output DC-DC converter provides +5 V, +12 V, and -12 V to the CDMS and system sensors. The single output DC-DC converter provides 12 V to the MPNE electro-mechanical devices. All connections are hermetically sealed. An electromagnetic interference filter is included to block conducted Electro-Magnetic Interference (EMI).

An alkaline battery powers a clock in the CDMS. The clock provides true event time logging throughout the mission.

Flight Hardware: Microgravity Plant Nutrient Experiment (MPNE) (continued)

The MPNE Payload Container houses all systems and components that comprise the MPNE payload. The container includes fans that provide convective cooling for the CDMS, light bank and power converter. Filters upstream of the fans prevent debris in the cabin from entering the payload.

The ON or OFF status of the MPNE Power are constantly displayed on the front face of the container. A Liquid Crystal Display (LCD) module displays payload status and error messages. The front face of the container also includes a power circuit breaker and a power connector.

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: Data Loggers

DATA LOGGERS

KSC payloads utilize small data loggers flown regularly in the Biological Research In Canisters (BRIC) payloads (which have no active environmental control) in order to have a record of the temperature, relative humidity, and ambient pressure. These data loggers are certified for flight aboard the Space Shuttle in various applications including the Extra-Vehicular Activity (EVA) suits worn by the astronauts. A detailed description of each the three varieties of data loggers follows.

HUMIDITY DATA LOGGER

Dimensions: 1.8” X 1.9” X 0.6”
Power Requirement: 3.6 V Battery
Weight: 0.9 oz

The HOBO RH is a general purpose relative humidity logger that is both durable and reusable. Its sensor resists chemical corrosion by chlorine, acetone, pentane, xylene, formaldehyde, ammonia, hospital germicides and freon. Using BoxCar® or LogBook® software for Windows or Mac, the HOBO RH can be programmed to record for a specific duration, unplugged from the computer,
and deployed. When the HOBO RH has finished recording, it is attached to the computer (via an RS-232 cable), and BoxCar or LogBook is used to read out and plot the collected information.

Features:

- Rated 5% to 95% RH non-condensing
- Accuracy ±5% tolerance at room temperature
- Two year battery life (user replaceable)
- Nonvolatile EEPROM memory retains data when the battery has been removed
- Stores up to 1800 measurements
- Safe operating temperature range of electronics is 08C to 608C, non-condensing
- Small size: 1.8" tall x 1.9" wide x 0.6" thick and 0.9 oz.
- Preselected intervals from 0.5 seconds to 4.8 hours, corresponding to deployment durations up to 360 days
- Blinking light confirms operation
- Data exportable to spreadsheet programs (Lotus, Excel, etc.)

PRESSURE DATA LOGGER

Dimensions: 1.8” X 1.9” X 0.6”
Power Requirement: 3.6 V Battery
Weight: 0.9 oz

The HOBO Pressure is a general purpose pressure/altitude logger that is both durable and reusable. Its pressure range runs from about 3% of atmospheric pressure to about 110% of standard sea level pressure. Using BoxCar® or LogBook® software for Windows or Mac, the HOBO Pressure is set to record for a specific duration, unplugged from the computer, and deployed. When the HOBO Pressure has finished recording, it is attached to the computer (via an RS-232 cable) and BoxCar or LogBook is used to read out and plot the collected information.

Features:

- Pressure range 0.5 to 16 psia
- Two year battery life (user replaceable)
- Nonvolatile EEPROM memory retains data when the battery has been removed
- Stores up to 1800 measurements
- Safe operating temperature range of -398C to +758C, non-condensing
- Small size: 1.8" wide x 1.9" tall x 0.6" thick and 0.9 oz.
- Preselected intervals from 0.5 second to 4.8 hours, corresponding to deployment durations up to 360 days
- Wide variety of pressure/altitude units
- Blinking light confirms operation
- Data exportable to spreadsheet programs (Lotus, Excel, etc.)

TEMPERATURE DATA LOGGER

Dimensions: 1.8” X 1.9” X 0.6”
Power Requirement: 3.6 V Battery
Weight: 0.9 oz

The HOBO XT temperature logger provides an external sensor for recording temperature in hard to reach areas. Using software for Windows or Mac, the HOBO XT can be programmed to record for a specific duration. When recording is finished, the unit is attached to the computer (via an RS-232 cable) and the data is read out and plotted.

Features:

Three standard ranges: -58C to +378C; -378C to +468C; and -398C to +1238C
Two year battery life (user replaceable)
Precision external thermistor probe on a flexible cable (ordered separately)
Standard cable lengths are 1, 2 and 6 feet
Operating temperature of logger is -398C to +758C
Optional submersible case rated to 400' depth
Small size: 1.8" tall x 1.9" wide x 0.6" thick and 0.9 oz.
Nonvolatile EEPROM memory retains data even when the battery has been removed
Stores up to 1800 measurements
Preselected intervals from 0.5 second to 4.8 hours,
corresponding to deployment durations up to 360 days
Blinking light confirms operation
Data readout in less than 30 seconds
Data exportable to spreadsheet programs (Lotus, Excel, etc.)

For further information, please contact Cynthia Martin at the Kennedy Space Center. telephone: (407) 867-4550.

Flight Hardware: ASTROCULTUREô Plant Growth Unit

Description:

The ASTROCULTUREô flight unit (ASC) was developed by the Wisconsin Center for Space Automation and Robotics, University of Wisconsin-Madison. The flight unit includes a controlled environment chamber for supporting plant growth in a microgravity environment for up to 3 months. The single middeck locker unit is energy efficient (less than 150 W) and lightweight (less than 32 kg including the locker). On-board sensors for monitoring and controlling the environmental parameters, video recording capability, and virtually autonomous operation make this a unit that can accommodate a variety of plant experiments. Data are available for assessment of performance capabilities.

Functional Capabilities:

Totally enclosed plant chamber, 14 x 14 cm growing area, 25 cm growing height not including the root zone

Temperature control in plant chamber over range of 188 C to 408 C, ± 18 C

Humidity control in plant chamber over the range of 50% to 95% RH, ± 2% RH

LED lighting unit with total intensity of 600 µmol m^{-2} s^{-1},(including 50 µmol m^{-2} s^{-1} blue photons) and ratio of blue to red photons adjustable from 0 to full output

Carbon dioxide concentration control in plant chamber over range of 300-2000 ppm

Ethylene removal unit

Porous tube water and nutrient delivery system

Environmental parameter monitoring and recording data acquisition system

On-orbit video and digital data download and subsequent downlink capability

Flight History:

STS-50, USML-1, Columbia, 6/25/92 - 7/9/92
STS-57, SPACEHAB-1, Endeavour, 6/21/93 - 7/1/03
STS-60, SPACEHAB-2, Discovery, 2/3/94 - 2/11/94
STS-63, SPACEHAB-3, Discovery, 2/3/95 - 2/11/95
STS-73, USML-2, Columbia, 10/20/95 - 11/5/95
STS-89, MIR, Endeavour, 1/20/98 - 5/15/98

For further information, please contact:

Wisconsin Center for Space Automation and Robotics
College of Engineering
University of Wisconsin-Madison
Room 2348 Engineering Hall
1415 Engineering Drive
Madison, Wisconsin 53706-1691
Phone: (608) 262-5524
Fax: (608) 262-9458
e-mail: bula@engr.wisc.edu

Flight Hardware: Plant Generic Bioprocessing Apparatus (PGBA)

Description

BioServe's Plant Generic Bioprocessing Apparatus, designed with support from WCSAR at the University of Wisconsin, NASA/Ames and NASA/Code UX, has successfully supported biotechnology experiments in space that examine changes in plant growth and related downstream biochemical consequences, especially production of secondary metabolites. PGBA has also demonstrated the successful development of several challenging systems for autonomous support of plants in the spaceflight environment. PGBA consists of several subsystems such as the outer enclosure module (the structural interface to the orbiter), the internal plant growth chamber, the atmosphere isolation and control system, the heat removal (temperature control) and humidity control system, as well as the nutrient delivery and rooting matrix system. Data acquisition for PGBA includes plant growth data through video and plant performance data. All sensor data are recorded by the PGBA Data Acquisition and Control Computer while an internal video camera provides video images that can be recorded or down-linked to Earth in near real-time. Light levels, plant growth chamber volume and instrumentation provided by PGBA are not currently available in any other microgravity plant growth facility.

Carrier PGBA first flew on shuttle mission STS-77 in May of 1996 (10 day duration), and again on the shortened Spacelab MSL-1 flight (STS-83) in April of 1997 (4 day actual) with subsequent re-flight aboard STS-94 in July (16 day duration).

Functional Capabilities

Power Supply	18-36 VDC (230 W peak at 28 VDC)
Mass	53.5 kg
Volume	H 56 cm x W 46 cm x D 51 cm (double middeck locker)
Plant Growth Volume	25 cm x 30 cm base x 30 cm high (6.6 cm root depth)
Rooting and Nutrient Matrix	- 30 individual 'bags' that can hold up to four plants each - Solidified nutrient agar or soil in gas exchange bag with and without water resupply capabilities (mission dependent)
Light	Compact fluorescent lamps, up to 550 μmol m^{-2} s^{-1} at top (100% power regulation), with a minimum of 220 μmol m^{-2} s^{-1} at root/shoot level (60% power regulation)
Environmental Control	20-32 ± 0.5? C air temperature, 75 - 100 ± 5 % RH 300 - 3000 ± 35 ppm CO_2, ≈ 21% O_2 (≈ 30% if EVA)
Data	On board recording of 32 channels (environmental data: temperature, pressure, humidity, carbon dioxide, oxygen); data downlink and payload commanding through orbiter data system, video downlink or on-board storage (digital)

Contacts Dr. Alex Hoehn ph: (303) 492-5875 fax: (303) 492-8883
hoehn@spot.colorado.edu
Dr. Louis Stodieck ph: (303) 492-4010 fax: (303) 492-8883
stodieck@stripe.colorado.edu

Flight Hardware: Biomass Production System (BPS) Plant Growth Unit

Equipment Provider: Orbital Technologies Corporation (ORBITEC)
Available Date: December 1998

Description
The Biomass Production System (BPS) provides precise environmental control for plant science and biotechnology experimentation. The BPS replaces two middeck lockers (vertically) and operates using 28 VDC orbiter power. The BPS provides it's own backplate and shell and is easily configurable for the Shuttle Middeck, the SpaceHab Module, and the EXPRESS Rack. The baseline BPS unit contains 4 chambers which are removable to provide access to specimens through all phases of operation. Each chamber is 6.5"(L) x 5.8"(W) x 7.4"(H) and provides independent control of temperature, humidity, lighting and CO_2 levels. The chambers are sealed to allow for *in situ* gas exchange measurements (e.g., photosynthesis, respiration). The current BPS design can be adapted to accommodate different chamber configurations including 2 tall chambers 6.5"(L) x 5.8"(W) x 15.9"(H), 2 long chambers 6.5"(L) x 14.8"(W) x 7.4"(H), or a single large chamber 6.5"(L) x 14.8"(W) x 15.9"(H).

Functional Capabilities
System performance specifications for BPS include:

- Temperature: 18-35 degrees C
- Relative Humidity: 60-90%
- Light Level: 50-400 µmol m^{-2} s^{-1}: baseline cool white fluorescent lamps
- CO_2 Enrichment: to 3000 ppm
- Water Supply/Collection: Two 750 mL reservoirs

Major functional features of the BPS include:

- Advanced control system including automated diagnostics
- Flexible data handling programmability
- Menu driven interface with optional user defined displays
- Enhanced data and image acquisition/storage, including IR and color video
- Serial port and Ethernet for direct data interface
- Multiple gas/liquid sampling ports
- Active nutrient delivery system, scarred for all other nutrient delivery systems
- Metering of nutrient supply & condensate recovery systems in 0.03 mL increments
- Real time video output
- High resolution color front panel display
- Interface keypad
- Operational status indicators
- Interfaces for standard keyboard and monitor for ground operations
- Subsystems modular design for servicing/replacement w/alternative configurations
- Fully equipped 486 computer
- Replenishable CO_2 supply, H_2O supply, Regenerative H_2O recovery loop

Contacts Mr. Thomas Crabb or Dr. Robert Morrow
Ph: (608) 827-5000 Fax: (608) 827-5050 Email: crabbt@orbitec.com

APPENDIX D
NRA 98-HEDS-01

Instructions for Proposal Preparation and Required Application Forms

This section contains the general instructions for proposal preparation and the specific forms required by proposers responding to agency solicitations in the Space Life Sciences in 1998. The forms at the end of this section include the following:

Form A	Solicited Proposal Application
Form B	Proposal Abstract
Form C	Space-Flight Experiment Supplementary Application (required for Flight Experiments only)
Form D	Checklist for Proposers
Form E	Multinational Space Station Human Research Informed Consent
Form US-1	Detailed Budget, First Year
Form US-2	Detailed Budget, Entire Project Period
Form US-3	Certification Regarding Drug-free Workplace Requirements
Form US-4	Certification Regarding Debarment, Suspension, and Other Responsibility Matters
Form US-5	Certification Regarding Lobbying

Instructions for Proposal Preparation

The information contained in these instructions is specific to this Announcement and supplements the general guidance provided in Appendix B.

All U.S. proposals should include one copy of each of the forms provided in this Appendix as part of the complete submission, with the exception of Form C that is submitted only with flight experiments, and/or Form E to be submitted if human research is proposed for the International Space Station. Non-U.S. proposals with no U.S. component are not required to submit Forms US-1, US-2, US-3, US-4, or US-5.

The proposal should include the following material, **in this order**:

(1) Transmittal Letter*
(2) Cover Page: Solicited Proposal Application (Form A)*
(3) Proposal Abstract (Form B)
(4) Detailed Budget, 12 Month (Form US-1)
(5) Detailed Budget, Entire Project Period (Form US-2)
(6) Proposal Title Page, with Notice on Restriction on Use and Disclosure of Proposal Information, if any
(7) Project Description
(8) Space Flight Experiment Supplementary Application Information (to be submitted with flight experiments only) (Form C)
(9) Management Approach
(10) Personnel
(11) Facilities and Equipment
(12) Supporting Budgetary Information
(13) Special Matters (specific information on animal and/or human subjects protocol approval required, if applicable)*
(14) Certification Regarding Drug-Free Workplace (Form US-3)*
(15) Certification Regarding Debarment, Suspension, and Other Responsibility Matters (Form US-4)*
(16) Certification Regarding Lobbying (Form US-5)*
(17) Checklist for Proposers (Form D)
(18) Appendices, if any
(19) Computer diskette (3.5 inch, Macintosh or PC format) containing an electronic copy of the principal investigator's name, address, telephone and fax numbers, e-mail address, and the complete project title and abstract as provided on Form B

* One signed original required

Except for the Project Description Section which is limited to 25 pages, there is no specific page limitation on proposals submitted. However, every effort should be made to keep proposals as brief as possible. The name of the Principal Investigator should appear in the upper right hand corner of each page of the proposal, except on the forms in this Appendix where special places are provided for this information. Note that the proposal must specify the period of performance for the work described; periods of performance may be for any duration up to three (3) years but should be suitable for the project proposed.

(1) Transmittal Letter

The transmittal letter should contain at least:

(a) The legal name and address of the organization and specific division (or campus identification if part of a larger organization) that proposes to carry out the project
(b) A brief project title intelligible to a scientifically literate reader and suitable for use in the public press
(c) The name and telephone number of the Principal Investigator and business personnel who may be contacted during evaluation or negotiation
(d) The identification of the specific NRA, by number and title, to which the proposal is responding
(e) The signature of the responsible official or authorized representative of the organization, or any other person authorized to legally bind the organization

A copy of the Checklist for Proposers (Form D) should be attached to this letter. Only one copy of the transmittal letter is required; it should be attached to the single original signature version of the submitted proposal.

(2) Cover Page: Solicited Proposal Application (Form A)

The information on Form A must be filled out completely, and one original signature version of this form should be submitted with the transmittal letter described above.

For Item (7) on this form, new means that a proposal for this project has not been submitted to NASA in 1996 or 1997, renewal means that this proposal is for the continuation of an currently funded task beyond the term of the funded proposal, and revised means that this proposal represents a revision of a proposal submitted to NASA and reviewed in 1996 or 1997, but not funded. A proposal previously submitted but not funded should be termed revised even if the original Principal Investigator has changed for 1998. Renewal and revised applications should contain special material described in the Project Description section below.

Note: items (9) and (10) on Form A require assurance of compliance with human subject and/or animal care provisions of NASA regulations (see Special Matters section below). Applicants should be aware that proposal review will not be undertaken without prior assurance of compliance.

(3) Proposal Abstract (Form B)

The information requested on this form is essential to the review of the proposal. It determines how the application will be evaluated and which program manager(s) will receive the final review materials for possible inclusion in one of the research programs of the Life Sciences Division.

(4) Detailed Budget, 12 Month (Form US-1)
(5) Detailed Budget, Entire Project Period (Form US-2)

These forms are self-explanatory budget forms that must be submitted with each U.S. proposal, or with non-U.S. proposals that have a U.S. component for which NASA funding is sought.

Foreign proposals with no U.S. component should not submit these forms but, as explained in Appendix A, should be endorsed in writing by the respective government agency or funding/sponsoring institution in that country from which the non-U.S. participant is proposing.

This endorsement should indicate that:

(a) The proposal merits careful consideration by NASA, and

(b) If the proposal is selected, sufficient funds will be made available to undertake the activity as proposed.

(6) Proposal Title Page, with Notice on Restriction on Use and Disclosure of Proposal Information, if Any

The title page should contain the project title, name and address of the submitting institution, the name, address and telephone number of the Principal Investigator, and the names and institutions of any co-investigators. It is NASA policy to use information contained in proposals for evaluation purposes only. While this policy does not require that the proposal bear a restrictive notice, offerors or quoters should, in order to maximize protection of trade secrets or other information that is commercial or financial and confidential or privileged, place the following notice on the title page of the proposal and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. In any event, information (data) contained in proposals will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice.

NOTICE

Restriction on Use and Disclosure of Proposal Information

The information (data) contained in [insert page numbers or other identification] of this proposal constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed other than for evaluation purposes; provided, however, that in the event a contract (or other agreement) is awarded on the basis of this proposal the Government shall have the right to use and disclose this information (data) to the extent provided in the contract (or other agreement). This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

(7) Project Description

The length of the Project Description section of the proposal should not exceed 25 pages using regular (12 point) type. The proposal should contain sufficient detail to enable reviewers to make informed judgments about the overall merit of the proposed research and about the probability that the investigators will be able to accomplish their stated objectives with the resources requested and with their own resources. In addition, the proposal should indicate clearly the relationship between the proposed work and the research emphases defined in this Announcement. The project description should be consistent with the type of proposal that is being submitted (ground-based research investigation or space-flight experiment). If an investigator wishes to propose related studies of two different types (e.g., a ground-based research investigation and a related space-flight experiment), then two proposals should be submitted with their linkage described in each proposal.

Renewal applications (for competing renewal of currently funded activity) must include a progress report as an Appendix to the proposal, and should refer to this Appendix appropriately throughout the Project Description section.

Revised applications (revisions of 1996 or 1997 submissions) must include, as part of the Project Description section, an **Introduction** that contains responses to the criticisms of the previous

review. Applicants should highlight the changes they have made in their research plan by appropriate bracketing, indenting, or changing of typography. Clearly present any work done since the prior version was submitted. Note that revised applications that do not address the criticisms in the previous critique and/or do not include substantial revisions may be penalized in the review process.

(8) Space-Flight Experiment Supplementary Application Information (if applicable, Form C)

All applicants proposing space flight research must complete Form C. The information on this form is essential for the evaluation of the feasibility of performing the proposed study.

(9) Management Approach

Each proposal must specify a single Principal Investigator who is responsible for carrying out the proposed project and coordinating the work of other personnel involved in the project. In proposals that designate several senior professionals as key participants in the research project, the management approach section should define the roles and responsibilities of each participant, and note the proportion of each individual's time to be devoted to the proposed research activity. The proposal should state clearly and unambiguously whether these key personnel have reviewed the proposal and endorsed their participation.

(10) Personnel

The Principal Investigator is responsible for direct supervision of the work and must participate in the conduct of the research regardless of whether or not compensation is received under the award. A short biographical sketch of the Principal Investigator that includes his or her current position title and educational background, and a list of principal publications and any exceptional qualifications must be included. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Provide similar biographical information on other senior professional personnel who will be directly associated with the project. Provide the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

(11) Facilities and Equipment

Describe the available facilities and major items of equipment specially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Provide evidence that such facilities or equipment will be made available if the applicant is successful in obtaining funding. Before requesting a major item of capital equipment, the proposer should determine if sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. The need for items that typically can be used for both research and non-research purposes should be explained.

(12) Supporting Budgetary Information

This section must include the supporting information required by Forms US-1 and US-2. In this NRA, the terms "cost" and "budget" are used synonymously. Sufficient proposal cost detail and supporting information are required; dollar amounts proposed with no explanation (e.g., Equipment: $1,000, or Labor: $6,000) may cause delays in evaluation and award. Generally,

NASA will evaluate costs as to reasonableness, allowability, and allocation. The budgetary forms define the desired detail, but each category should be explained in the body of the proposal. Offerors should exercise prudent judgment in determining what to include in the proposal, as the amount of detail necessarily varies with the complexity of the proposal.

The following examples indicate the suggested method of preparing a cost breakdown:

Direct Labor

Labor costs should be segregated by titles or disciplines with estimated hours and rates for each. Estimates should include a basis of estimate such as currently paid rates or outstanding offers to prospective employees. This format allows the Government to assess cost reasonableness by various means including comparison to similar skills at other organizations. Example:

	Hours	Rate	Amount
Principal Investigator	100	$19.34	$1,934
Co-Investigator	450	$11.78	$5,301
Clerical Support	75	$ 8.70	$ 652
Total	625		$7,887

Indirect Costs

Indirect costs should be explained to an extent that will allow the Government to understand the basis for the estimate. Examples of prior year historical rates, current variances from those rates, or an explanation of other basis of estimates should be included. Where costs are based on allocation percentages or dollar rates, an explanation of rate and application base relationships should be given. For example, the base to which the General and Administrative (G&A) rate is applied could be explained as: application base equals total costs before G&A less subcontracts.

Other Costs

Each significant cost category, such as travel, should be detailed, explained, and substantiated. Past experience has indicated that up to six trips may be necessary for a flight experiment [i.e., Crew Familiarization (Johnson Space Center, JSC), pre-flight Science Verification Test (Kennedy Space Center, KSC), L-14 day Press Briefing (JSC), Mission Preparation/Operations (KSC), Post-Flight Ground Control (KSC), Post-Flight Results Symposium]. Format should be as follows:

Travel Costs

Destination	Duration	Airfare	Per Diem	Total
Moffett Field, CA	3 days	$500	$300	$ 800
Washington, DC	1 day	$500	$100	$ 600
Total				$1,400

If the proposal is for competitive renewal of an ongoing research effort beyond the present period of approval, the proposal cost section should include an estimate of any significant amount of unspent or uncommitted funds remaining at the completion of the current period of performance.

The supporting budgetary information section of the proposal should include information concerning other current projects being conducted by the Principal Investigator and funded either by NASA or any other Government agency. Also include other proposed or pending projects. Provide the title of the project, the sponsoring agency, the project period, the investigator's time commitment, and the value of the project. The following format is recommended:

Funding Organization	Title	Number	Total Project Period	Total Effort	Direct Costs
NIH	Bone Mineralization	R01 NS 01234-06	12/96-11/99	30%	$100,000
NSF	Plant Growth	DRF 7683-05	6/95-5/98	10%	$20,000

(13) Special Matters

The Special Matters section must contain a statement from the proposer's institution which states that the proposed work will meet all Federal and local human subject requirements and animal care and use requirements, if applicable. Note that no animal subjects may be utilized unless specific information justifying and describing their use is included in the proposal. Policies regarding the protection of human research subjects in NASA-sponsored research are detailed in NASA Management Instruction (NMI) 7100.8B (Protection of Human Research Subjects), and animal care and use requirements are detailed in the NASA Code of Federal Regulations (CFR) 1232 (Care and Use of Animals in the Conduct of NASA Activities), both of which are available from the Life Sciences Division, Code UL, NASA Headquarters, Washington, DC 20546. Assurance of compliance with human subject and/or animal care provisions is required on Form A, to be submitted with each proposal. In addition, a letter signed by the chairperson of the Institutional Review Board (IRB) or institutional Animal Care and Use Committee (ACUC) or both, as appropriate, regarding approval of the experimental protocol, should be included with each copy of the proposal. All non-NASA proposals providing ACUC approval must also contain the institution's Public Health Assurance number. All non-US proposals should provide certification from the investigator's institution stating that the proposal has been reviewed and approved and is in compliance with international regulations on bioethics standards for the use of animals or humans in research. Applicants should note that this is a mandatory requirement: **Review of the proposal will not be undertaken until this information is supplied to NASA.**

(14) Certification Regarding Drug-Free Workplace (Form US-3)
(15) Certification Regarding Debarment, Suspension, and Other Responsibility Matters (Form US-4)
(16) Certification Regarding Lobbying (Form US-5)

These three certifications are required of all U.S. applicants before a grant/contract can be awarded. They are not required of foreign proposals with no budget section.

(17) Checklist for Proposers (Form D)

One copy of a completed version of this checklist should be attached to the transmittal letter.

(18) Appendices, if Any

Renewal applications (for competing renewal of currently funded activity) must include an appendix providing a Progress Report of the previously funded activity. This report should provide the beginning and ending dates for the period covered since the project was last reviewed competitively and provide a list of all personnel who have worked on the project

during this period (including dates of service and percentages of their appointments devoted to the project). The report should also summarize the previous project's original goals and specific objectives and provide a succinct account of published and unpublished results indicating progress toward their achievement. Changes in these objectives during the course of the project and a rationale for these changes should be presented. The importance of the findings should be summarized and discussed. Finally, a list should be provided of the titles and complete references to all publications, manuscripts submitted or accepted for publication, patents, invention reports, and other printed materials that have resulted from the project since it was last competitively reviewed.

Other appendices may be appropriate for particular proposals.

(19) Computer Diskette

A diskette (3.5 inch, Macintosh or PC format) should contain an electronic copy of the Principal Investigator's name, address, telephone and fax numbers, e-mail address, and the complete Project Title and Abstract as provided on Form B

FORM A

SOLICITED PROPOSAL APPLICATION FOR SPACE LIFE SCIENCES

IN RESPONSE TO ANNOUNCEMENT #_____

PLEASE FOLLOW INSTRUCTIONS CAREFULLY

LEAVE BLANK

NUMBER

REVIEW GROUP

DATE RECEIVED

1. COMPLETE TITLE OF PROJECT

2. PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR *(First, middle, and last name; degrees; position title)*

3. COMPLETE MAILING ADDRESS

Internal Mail Code or Location
Office or Organization Division
Agency/Center, Company, or Institution
Street or P.O. Box
City, State, Zip Code

4. TELEPHONE NUMBER *(area code, number, extension)*

FAX NUMBER

E-MAIL ADDRESS

5. CONGRESSIONAL DISTRICT (U.S. ONLY)

6. SOCIAL SECURITY # (U.S. ONLY)

7. IS THIS PROPOSAL ☐ NEW ☐ RENEWAL ☐ REVISED

8. HAS THIS PROPOSAL (OR SIMILAR REQUEST) BEEN SUBMITTED TO ANY OTHER AGENCY?
☐ No ☐ Yes IF YES, SPECIFY AGENCY AND YEAR SUBMITTED:

9. HUMAN SUBJECTS

9a. ☐ No ☐ Yes

9b. EXEMPTION # OR IRB APPROVAL DATE_____

9c. Assurance of Compliance #_____

10. VERTEBRATE ANIMALS

10a. ☐ No ☐ Yes

10b. ACUC Approval Date_____

10c. PHS Animal Welfare Assurance #_____

11. CO-INVESTIGATORS *(First, middle, and last name; degrees)*

12. CO-INVESTIGATOR'S ORGANIZATION

13. DATES OF ENTIRE PROPOSED PROJECT PERIOD	14. COSTS REQUESTED FOR FIRST 12-MONTH BUDGET PERIOD		15. COSTS REQUESTED FOR ENTIRE PROPOSED PROJECT PERIOD	
	14a. Direct Costs	14b. Total Costs	15a. Direct Costs	15b. Total Costs
From:				
Through:	$	$	$	$

16. APPLICANT ORGANIZATION *(Organization Name)*

17. TYPE OF ORGANIZATION (U.S. ONLY)
☐ Non Profit ☐ For Profit *(General)* ☐ For Profit *(Small Business)* ☐ Public, Specify: ☐ Federal ☐ State ☐ Local

18. ORGANIZATION OFFICIAL TO BE NOTIFIED IF AN AWARD IS MADE *(Name, title, address and telephone number)*

19. OFFICIAL SIGNING FOR APPLICANT ORGANIZATION *(Name, title, and telephone number)*

20. PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR ASSURANCE: I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if a grant is awarded as a result of this application. Willful provision of false information is a criminal offense (U.S. Code, Title 18, Section 1001).

SIGNATURE OF PERSON NAMED IN 2
(In ink "Per" signature not acceptable.)

DATE

21. CERTIFICATION AND ACCEPTANCE: I certify that the statements herein are true and complete to the best of my knowledge, and accept the obligation to comply with NASA terms and conditions if a grant is awarded as the result of this application. A willfully false certification is a criminal offense (U.S. Code, Title 18, Section 1001).

SIGNATURE OF PERSON NAMED IN 17
(In ink "Per" signature not acceptable.)

DATE

FORM B

PROPOSAL ABSTRACT

Principal Investigator: _____

Co-Investigators: _____

_____

_____

Proposal Title: _____

_____

Ground-Based Research _____ **OR** **Space-Flight Experiment** _____

Abstract

{Prepare a brief description of the application stating the broad, long-term objectives and specific aims of the proposed work. Describe concisely the research design and methods for achieving these objectives and aims. This abstract is meant to serve as a succinct and accurate description of the proposed work when separated from this application. Limit abstract to 300 words or fewer.}

Program Element Applicability:

{Place a check mark in the column next to the program that is most closely aligned with your proposal.}

SPACE HUMAN FACTORS ENGINEERING _____
ADVANCED LIFE SUPPORT (Bioregenerative) _____
ADVANCED LIFE SUPPORT (Physical/Chemical) _____
ADVANCED ENV. MONITORING & CONTROL _____

FORM C

SPACE FLIGHT EXPERIMENT SUPPLEMENTARY APPLICATION FORM

This following form must be completed by all investigators proposing flight experiments. This form should be inserted into the Project Description section of the proposal. (Provide responses on additional sheets, as necessary.)

Principal Investigator _____

Proposal Title _____

Type of Flight Experiment: ____Short Duration ____Long Duration

(1) If humans are required as subjects for the proposed investigation, please list:
   a) number of subjects
   b) special subject restrictions, such as specific dietary regimens or fluid intake regulation
   c) special experiment protocols, such as specific work/rest cycles or exercise
   d) physiological variables to be measured.

(2) If non-humans are required for the proposed investigation, please list:
   a) scientific name of species and common name
   b) gender, strain, age, stage, and weight (if applicable)
   c) minimum number required, desired number, and a rationale for both
   d) special requirements for maintenance or manipulation of the specimens.

(3) List major hardware items required in this investigation.

(4) Estimate access time.
   a) Is late access needed and when (i.e., do you need to load the experiment and/or species within a certain time period before a launch?)?
   b) Is early removal needed and when (i.e., do you need to remove the experiment and/or species within a certain time period after landing? If so, please specify requirement.)?

(5) Identify potentially hazardous materials, including biowaste.

(6) Are there any specific conditions requested, such as air composition, humidity, temperature control, or illumination?

(7) For Space Station experiments, estimate the maximum and minimum number of days of microgravity exposure required.

(8) Estimate the total set of operations required to carry out the experiment in space (e.g., the number of sessions of crew activity and the time required for each session).

(9) Estimate amount of time for crew participation with experiment before, during and after flight (e.g., data collection, crew training, etc.).

****

Responses (continue on additional sheets):

FORM D

CHECKLIST FOR PROPOSERS

This checklist should be enclosed with the transmittal letter and annotated to indicate that the stated items have been included in the proposal package.

Principal Investigator/Program Director _____

_____ Form A: Solicited Proposal Application*	_____ Facilities and Equipment Description
_____ Form B: Proposal Abstract	_____ Supporting Budgetary Information (include current and pending support: list of other funded projects)
_____ Form US-1: Detailed 12 month Budget (First year of support)	_____ IRB or ACUC letter/ form regarding protocol approval, if applicable*
_____ Form US-2: Summary Budget Form	_____ Form US-3: Certification Regarding Drug-Free Workplace*
_____ Title Page	_____ Form US-4: Certification Regarding Debarment, Suspension, and Other Responsibility Matters*
_____ Project Description	_____ Form US-5: Certification Regarding Lobbying*
_____ Form C: Space-Flight Exp. Supplementary Information (if applicable)	_____ Appendices, if any
_____ Management Approach	_____ 25 copies of all material listed above
_____ Personnel, CVs; Biographical Summaries	_____ 3.5 inch computer diskette

*One signed original form required.

Only one copy of the following materials needs to be submitted:

_____ Transmittal Letter

_____ Form D: This checklist indicates all items have been enclosed

FORM E

MULTINATIONAL **SPACE STATION**
HUMAN RESEARCH INFORMED CONSENT*

1. I, the undersigned, do voluntarily give my informed consent for my participation as a test subject in the following research study, test, or investigation:

NAME OF INVESTIGATION_____

_____

MISSION TO WHICH ASSIGNED_____

PRINCIPAL INVESTIGATOR _____

RESPONSIBLE PROJECT SCIENTIST _____

I understand or acknowledge that:

(a) This procedure is part of an investigation approved by participating agencies.

(b) I am performing these duties as part of my employment with_____.

(c) This research study has been reviewed and approved by the Multinational Review Board (MRB) which has also determined that the investigation involves _____ risk to the subject. (minimal or reasonable)

(d) Definitions:
"Minimal risk" means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

"Reasonable risk" means that the probability and magnitude of harm or discomfort anticipated in the research are greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests, but that the risks of harm or discomfort are considered to be acceptable when weighed against the anticipated benefits and the importance of the knowledge to be gained from the research.

(e) The research procedures were explained to me prior to the execution of this form. I was afforded an opportunity to ask questions, and all questions asked were answered to my satisfaction. A layman's description was provided to me.**

(f) I consider myself physically and mentally qualified to participate in the investigation.

(g) I know that I can refuse to participate in the tests at any stage of their performance, and my refusal will be honored, except in those cases when, in the opinion of the responsible physician, termination of the tests could have detrimental consequences for my health and/or the health of the other subjects. However, understanding the significance of the investigations (tests), I will give every effort to perform the full scope of the program.

(h) In the event of injury resulting from this study, I understand that I will receive medical attention and necessary treatment. I also understand that I will be compensated for any

injuries to the extent permitted under current (TBD) and the provisions of the contract between _(TBD). My agreement to participate shall not be construed as a release of (TBD) or any third party from any future liability which may arise from, or in connection with, the above procedures.

(i) Consistent with statutory and Agency-approved routine uses under the (TBD), the confidentiality of any data obtained as a result of my participation as a research subject in this study shall be maintained, so that no data may be linked with me as an individual. However, if a "life-threatening" abnormality is detected, the investigator will notify me and the _(TBD)_. Such information may be used to determine the need for care or medical follow-up, which, in certain circumstances, could affect my professional (flight) status.

_____

Test Subject Date

2. I, the undersigned, the Principal Investigator of the investigation designated above, certify that:

(a) I have accurately described the procedure and related risk(s) to the test subject.

(b) The test setup involves _____ risk to the test subject as determined by the MRB. (minimal or reasonable)

(c) All equipment to be used has been inspected and certified for safe and proper operation.

(d) The test subject is qualified to participate in my experiment protocol.

(e) The test protocol has not been changed from that originally approved by the MRB.

_____

Principal Investigator Date

Concurrence:

_____

Project Scientist Date

Notes:
* This form is valid for the period including preflight, in-flight, and postflight data collection sessions for the mission. Before the first baseline data collection, the Principal Investigator will repeat the briefing concerning risks involved in the investigation. A signed, dated copy of this form with attachments must be forwarded to Chair, Multinational Review Board.

** A detailed description of the investigation will be attached to this consent form. The Principal Investigator is responsible for formulating this document, which should be in layman's terms such that the subject clearly understands what procedures will be required and the risks associated therewith. The detailed description of the research procedures must specifically list the risks associated with the procedures to be employed, the possible adverse reactions of all medications to be administered, and the risks/hazards resulting from exposure to ionizing radiation. Further, the investigator must clearly specify all forms of subject behavior interdicted by the research protocol (exercise, diet, medications, etc.).

FORM US-1

PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR: _____

DETAILED BUDGET FOR 12-MONTH BUDGET PERIOD DIRECT COSTS ONLY		FROM		THROUGH	
Duplicate this form for each year of grant support requested		DOLLAR AMOUNT REQUESTS *(Omit cents)*			
PERSONNEL *(Applicant Organization Only)*		**EFFORT ON PROJECT**	**SALARY**	**FRINGE BENEFITS**	**TOTALS**
NAME	**ROLE IN PROJECT**				
	Principal Investigator				
SUBTOTALS →					
CONSULTANT COSTS					
EQUIPMENT *(Itemize, use additional sheet if needed)*					
SUPPLIES *(Itemize by category, use additional sheet if needed)*					
TRAVEL	DOMESTIC				
	NON-DOMESTIC				
OTHER EXPENSES *(Itemize by category, use additional sheet if needed)*					
TOTAL DIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD ***(Item 14a, Form A)***				**$**	
INDIRECT COSTS FOR FIRST 12-MONTH BUDGET PERIOD				**$**	
TOTAL COSTS FOR FIRST 12-MONTH BUDGET PERIOD ***(Item 14b, Form A)***				**$**	

FORM US-2

PRINCIPAL INVESTIGATOR/PROGRAM DIRECTOR: _____

BUDGET FOR ENTIRE PROJECT PERIOD DIRECT COSTS ONLY				
BUDGET CATEGORY TOTALS		**1st BUDGET PERIOD**	**ADDITIONAL YEARS OF SUPPORT REQUESTED**	
			2nd	**3rd**
PERSONNEL (Salary and Fringe Benefits) (Applicant organization only)				
CONSULTANT COSTS				
EQUIPMENT				
SUPPLIES				
TRAVEL	DOMESTIC			
	NON-DOMESTIC			
OTHER EXPENSES				
TOTAL DIRECT COSTS FOR EACH BUDGET PERIOD		**$**	**$**	**$**
TOTAL INDIRECT COSTS FOR EACH BUDGET PERIOD		**$**	**$**	**$**
TOTAL DIRECT + INDIRECT COSTS FOR EACH PERIOD		**$**	**$**	**$**
TOTAL DIRECT + INDIRECT COSTS FOR ENTIRE PROJECT				**$**

JUSTIFICATION FOR UNUSUAL EXPENSES (Detail Justification in Cost Section of Proposal)

FORM US-3

CERTIFICATION REGARDING DRUG-FREE WORKPLACE REQUIREMENTS

This certification is required by the regulations implementing the Drug-Free Workplace Act of 1988, 34 CFR Part 85, Subpart F. The regulations, published in the January 31, 1989 Federal Register, require certification by grantees, prior to award, that they will maintain a drug-free workplace. The certification set out below is a material representation of fact upon which reliance will be placed when the agency determines to award the grant. False certification or violation of the certification shall be grounds for suspension of payments, suspension or termination of grants, or government-wide suspension or debarment (see 34 CFR Part 85, Sections 85.615 and 85.620).

I. GRANTEES OTHER THAN INDIVIDUALS

A. The grantee certifies that it will provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing a drug-free awareness program to inform employees about --

(1) The dangers of drug abuse in the workplace;

(2) The grantees policy of maintaining a drug-free workplace;

(3) Any available drug counseling, rehabilitation, and employee assistance programs; and

(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will --

(1) Abide by the terms of the statement; and

(2) Notify the employer of any criminal drug statute conviction for a violation occurring in the workplace no later than five days after such conviction;

(e) Notifying the agency within ten days after receiving notice under subparagraph (d) (2) from an employee or otherwise receiving actual notice of such conviction;

(f) Taking one of the following actions, within 30 days of receiving notice under subparagraph (d) (2), with respect to any employee who is so convicted --

(1) Taking appropriate personnel action against such an employee, up to and including termination; or

(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or Local health, Law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e), and (f).

B. The grantee shall insert in the space provided below the site(s) for the performance or work done in connection with the specific grant: Place of Performance (Street address, city, county, state, zip code)

_____

_____

Check ____ if there are workplaces on file that are not identified here.

II. GRANTEES WHO ARE INDIVIDUALS

The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession or use of a controlled substance in conducting any activity with the grant.

_____

Organization Name AO or NRA Number and Title

_____

Printed Name and Title of Authorized Representative

_____

Signature Date

FORM US-4

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 34 CFR Part 85, Section 85.510, Participants' responsibilities. The regulations were published as Part VII of the May 28, 1988 Federal Register (pages 19160-19211). Copies of the regulations may be obtained by contacting the U.S. Department of Education, Grants and Contracts Service, 400 Maryland Avenue, S.W. (Room 3633 GSA Regional Office Building No. 3), Washington, D.C. 20202-4725, telephone (202) 732-2505.

A. The applicant certifies that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period preceding this application been convicted or had a civil judgement rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.

(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

_____

Organization Name AO or NRA Number and Title

_____

Printed Name and Title of Authorized Representative

_____

Signature Date

_____

Printed Principal Investigator Name Proposal Title

FORM US-5

CERTIFICATION REGARDING LOBBYING

As required by S 1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over $100,000, the applicant certifies that:

(a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;

(b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, an or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Organization Name and title — AO or NRA Number

Printed Name and Title of Authorized Representative

Signature — Date

Printed Principal Investigator Name — Proposal Title

NASA Research Announcement (NRA) Mailing List Update

Please use this form to update information for the NASA Office of Life & Microgravity Sciences & Applications (OLMSA) NRA mailing list. Please fill out **CONTACT INFORMATION** and **PROGRAM AREAS/DISCIPLINES** completely. Forms with incomplete addresses and/or without a Program or Discipline checked will not be accepted. Please fold the form, secure with tape (do not staple), and mail it back to the address on the reverse side. Proper postage must be applied.

Mailing list updates may also be submitted electronically via E-Mail or World Wide Web to the following addresses:
E-Mail: loi@hq.nasa.gov
World Wide Web: http://peer1.idi.usra.edu/

☐ **Please send me notifications of announcements via E-Mail only. See my E-Mail address below.**

Check one:

☐ 1. Please **ADD** my name to the mailing list.

☐ 2. Please **REMOVE** my name from the mailing list (please attach mailing label).

☐ 3. Please **CHANGE** my current listing (please attach mailing label).

☐ 4. Please leave my current listing **UNCHANGED** (please attach mailing label).

Contact Information

If your address has changed or your mailing label is incorrect, please provide COMPLETE contact information .

Prefix: (Mr., Mrs., Ms., Dr., Professor, etc.)

Suffix : (M.D., Ph.D., Jr., III, etc.)

Internet/E-Mail:

Name, First:

Last:

Position Title:

Mail Code, Loc :

Office, Dept, Div:

Org (Agency/Ctr, Univ):

Street or PO Box:

City:

State:

Zip Code:

Country:

Telephone No:

Fax No:

Institution Type

☐ 1. College or University
☐ 2. Minority College or University
☐ 3. Minority Business
☐ 4. NASA Center
☐ 5. Other Government Agency
☐ 6. Nonprofit Corporation
☐ 7. Small Business
☐ 8. Private Industry
☐ 9. Foreign Addressee

Program Areas/Disciplines

(check main area of interest)

☐ **1. Life Sciences**

- ☐ A. Advanced Life Support
- ☐ B. Advanced Technology Development
- ☐ C. Data Analysis
- ☐ D. Environmental Health
- ☐ E. Human Factors
- ☐ F. NSCORT
- ☐ G. Space Biology
- ☐ H. Space Radiation Health
- ☐ I. Space Physiology & Countermeasures

☐ **2. Microgravity Sciences**

- ☐ A. Biotechnology
- ☐ B. Combustion Science
- ☐ C. Fluid Physics
- ☐ D. Fundamental Physics
- ☐ E. Materials Science

1/9/98