NASA'S INTERNATIONAL SPACE STATION PROGRAM: STATUS AND ISSUES

Testimony Before the
Subcommittee on Space and Aeronautics
Committee on Science and Technology
U.S. House of Representatives

Jeffrey P. Sutton, M.D., Ph.D.
National Space Biomedical Research Institute

April 24, 2008

Statement of Jeffrey P. Sutton, M.D., Ph.D.

Before the

Subcommittee on Space and Aeronautics
Committee on Science and Technology
U.S. House of Representatives

April 24, 2008

Mr. Chairman, Ranking Member and Distinguished Members of the Subcommittee:

Thank you for the opportunity to testify on the subject of "NASA's International Space Station Program: Status and Issues." Since 2001, I have had the privilege to serve as the Director of the National Space Biomedical Research Institute (NSBRI), a non-profit consortium competitively selected and supported by NASA to address and develop countermeasures for high-priority biomedical risks associated with long-duration human exploration of space.

The International Space Station (ISS) provides a unique, invaluable resource for the U.S. and its international partners to conduct scientific research, develop and demonstrate innovative technologies, test and evaluate procedures, protocols and products, and operationally integrate hardware, software and other components to advance space exploration goals. Designation of the U.S. segment of the ISS as a National Laboratory, as specified in Section 507 of the NASA Authorization Act of 2005 (Public Law 109-155), underscores the importance of ISS as a facility for research and a means to enable exploration.

In the "Vision for Space Exploration," presented by President Bush on January 14, 2004, the use of ISS to support space exploration goals is highlighted, with one focus being to understand how the space environment affects astronaut health and capabilities and to develop countermeasures. The potential of ISS as an essential platform for biomedical and technology research to support long-term human exploration of space has been described in several recent reports, including but not limited to (1) "Review of NASA Plans for the International Space Station," prepared by the National Research Council in 2006, and (2) "NASA Report to Congress Regarding a Plan for the International Space Station National Laboratory," submitted in May 2007.

It is prudent for the U.S. to foster scientific and technological achievements utilizing the unique attributes of the ISS. Innovation and discovery contribute to American leadership and economic growth. Accomplishments in space help inspire the next generation of scientists, physicians and engineers, support U.S. competitiveness, facilitate partnerships and international cooperation, and lead to advances that enhance life on Earth. NASA and the nation face many challenges. As construction of the ISS nears completion and three scientific laboratories become operational, the time is ripe to capitalize on our country's investment in the ISS and all that it has to offer.

The present hearing examines the status of the ISS and issues related to its operation and utilization, including the planned and potential uses of the ISS to meet both NASA and non-NASA research needs. This testimony concerns itself with responses to a series of biomedical questions posed in the Subcommittee's invitation letter.

What biomedical research is needed to prepare for exploration beyond low Earth orbit?

In the 47 years since the first human flew in space, a significant amount of knowledge and experience has been acquired relating to the inherent risks associated with human space travel. Missions in low Earth orbit, especially long-duration flights aboard Skylab, Mir and ISS, have given insights into a broad range of human health risks associated with extended operations in the microgravity environment of space. Accelerated bone loss, muscle atrophy, changes in cardiovascular function, altered immune responses and sensorimotor adaptations occur. There are issues concerning proper nutrition, human-machine interfaces and habitability, neurobehavioral and psychosocial factors, performance, sleep and chronobiology, radiation and medical care capabilities, including ineffectiveness of medication. Some risks, such as dust from the lunar or Mars surfaces, are unique to missions beyond low Earth orbit. Not all astronauts are affected equally by the same risk or countermeasure, and individual differences need to be taken into account.

An understanding of the risks and issues is critical to determining what biomedical research is needed. The Institute of Medicine (IOM) report, "Safe Passage: Astronaut Care for Exploration Missions," released in 2001, recommended that all relevant epidemiological data on astronauts be captured, and that a long-term, focused healthcare research strategy be pursued concerning health risks and their amelioration.

The Bioastronautics Roadmap (http://bioastroroadmap.nasa.gov), developed over the past decade by NASA in collaboration with the external biomedical research community, is consistent with this perspective. The Roadmap provides a framework for identifying, assessing and reducing the risks of crew exposure to the hazardous environments of space. It identifies 45 risks and assigns priorities to these for three reference missions: a one-year mission to the ISS; a month-long stay on the lunar surface; and a 30-month round-trip journey to Mars.

NASA and its non-government organization partner, NSBRI, have used the Bioastronautics Roadmap as a framework to build a biomedical research portfolio focused on high-priority areas, such as accelerated bone loss, radiation, neurobehavioral and psychosocial factors, and exploration medical care. More recently, the partnership has been elucidating a level of detail necessary to prioritize risks across physiological disciplines and to compare strategies for how to manage a given risk across mission operational architectures.

Research on the ground and in space is needed to elucidate processes but the importance of accelerating countermeasure and technology development is also critical, as emphasized in an IOM report released in 2005 entitled "A Risk Reduction Strategy for Human Exploration of Space." To prepare for exploration beyond low Earth orbit, the report stresses the need to establish safe radiation exposure levels for all relevant risks. This sentiment is echoed in a 2008 report from the National Research Council entitled “Managing Space Radiation Risk in the New Era of Space Exploration.”

By its nature, research needs are dynamic as knowledge about risks matures and countermeasures and other risk-reduction strategies are implemented. ISS as a research platform provides an unparalleled resource to define requirements for exploration needs and to support research, development, testing, evaluation and operational integration of deliverables to support crew health and well-being.

What progress has been made to date?

Progress in biomedical research and development has been made in space and in ground-based investigations. Skylab, Space Shuttle (including dedicated life science missions such as STS-90 Neurolab), free flyers and the ISS have all pushed the frontier of biomedical knowledge and technology. Beginning with the arrival of Expedition 1 to the ISS in November 2000, and extending through the current Expedition 17 (launched April 8, 2008 with an expected return to Earth in October 2008) and Expedition 18 (expected launch and return in October 2008 and April 2009, respectively) missions, NASA reports a series of experiments devoted to human research and countermeasure development for exploration.[1]

A summary of these experiments with Earth applications follows:

- *Bone and Muscle Physiology in Space*
  Experiments include research seeking to understand the effects spaceflight on bone loss and muscle fatigue, kidney stone prevention, and developing countermeasures, such as the use of medicines and exercise. Potential Earth benefits include treatments and/or cures for diseases such as osteoporosis and spinal cord injuries.
- *Cardiovascular and Respiratory Systems in Space*
  Experiments include research to understand orthostatic intolerance, decompression sickness, and blood delivery to the brain. Earth applications include improved treatment of low blood pressure and prevention of cardiac deconditioning.
- *Human Behavior and Performance*
  Experiments include research on crew interaction, understanding behavioral issues and sleep cycles. Earth applications include improved treatment of insomnia and improved behavioral performance of people in high-stress situations.
- *Immune System in Space*
  Experiments include research on developing new wound healing technologies, understanding and monitoring immune system functions, and studying stress-induced reactivation of viruses. Earth applications include wound and tissue repair techniques that could prevent limb loss for military and civilian populations and rapid detection of stress-induced viruses, such as herpes, and improved treatment.
- *Integrated Physiology Studies*
  Experiments include research on development of telemedicine strategies, nutrition, and

[1] (http://www.nasa.gov/mission_pages/station/science/experiments/Human_Research.html)

archiving of biosamples that will provide future research opportunities. Earth applications include remote medical diagnosis and treatment capabilities for rural healthcare and greater understanding of nutrition on health.

- *Microbiology in the Space Environment*
  Experiments include research on development of hand-held technology to detect biological and chemical substances, understanding the threat of pathogens inside spacecraft, and studying the effect of reduced gravity on pathogens. Earth applications include advances in vaccine development, new treatments of drug-resistant virus strains, and diagnosis for potential sources of microbial contamination.
- *Neurological and Vestibular Systems in Space*
  Experiments include research on facilitating recovery of functional mobility after long-duration spaceflight, understanding hand-eye coordination difficulties in space, and studying medications to treat motion sickness. Earth applications included improved treatment of neurological diseases, more effective motion sickness treatment, and reduced risk of falling in the elderly.
- *Radiation Studies*
  Experiments include research on the radiation environment, effects of radiation on the brain, and assessing the risk of genetic damage caused by radiation. Earth applications include benefits for brain tumor treatment, insight on the origin of specific gene mutations, and improved radiation protection on military and civilian aircraft crews.

A significant step forward by NASA in implementing an integrated biomedical research program to support the long-term human presence, development and exploration of space occurred slightly more that a decade ago. In 1997, NASA competitively awarded, and has funded in increments based on performance, a cooperative agreement (NCC 9-58) to the National Space Biomedical Research Institute (www.nsbri.org). NSBRI works in partnership with NASA's Human Research Program, that is part of Advanced Capabilities within the Exploration Mission Systems Directorate. NSBRI leverages the nation's substantial investment in biomedical research and brings unprecedented intellectual and institutional resources to solve problems for NASA. The focus is on a team approach to developing countermeasures and deliverables in close collaboration with NASA (see Attachments A and B).

NSBRI is a virtual institute that currently supports approximately 65 coordinated and openly competed science, technology and education projects at 70 universities in 26 states. There is a well established pipeline of products, maturing through countermeasure and technology readiness levels, in preparation for flight testing, evaluation and, if appropriate, operational integration. Some projects have matured to flight, while the bulk of the effort is ground-based and serves as a source of biomedical research for the ISS National Laboratory.

As a nationally acclaimed translational research institute, NSBRI adds unique value to NASA's Human Research Program. NSBRI is governed by 12 consortium members, with combined annual biomedical funding in excess of $3B from the National Institutes of Health (NIH). There are strong productive collaborations not only with institutes within the NIH, in the spirit of the recent NASA-NIH Memorandum of Understanding, but also with programs within the Department of Defense, Department of Energy, U.S. Naval Academy, and other entities. More than one-third of NSBRI projects actively engage industry, and there is an excellent education and outreach program spanning elementary through high school, undergraduate, graduate, and postdoctoral education, and continuing medical education efforts related to space. There is an eminent Board of Directors (Attachment C) and active involvement of current and former astronauts and flight surgeons (Attachment D).

Examples of NSBRI supported science and technology projects include:[2]

- Understanding the harmful effects of space radiation in exacerbating bone loss caused by microgravity, with implications on Earth for patients receiving radiotherapy;
- Investigation of pharmacological countermeasures to limit hand and muscle fatigue in space, with applications on Earth to lessening muscle weakness following injury or surgery;
- Development and testing of a needle-free blood and tissue monitoring device for health assessment, science and medical care in space, with applications on Earth for use in ambulances, intensive care units, battlefield settings and monitoring of vascular function in diabetics;
- Research and applications of blue light to affect the human circadian pacemaker, performance and adaptation to shifts in work schedule, with applications on Earth to shift work;
- Delivery of a miniaturized time-of-flight mass spectrometer for environmental monitoring and medical assessment in space, with applications for homeland security;
- Research, development, testing and evaluation (aboard the NASA Extreme Mission Operations underwater habitat) of a psychomotor vigilance test for the objective assessment of fatigue and stress in mission-critical activities (Principal investigator awarded a NASA Distinguished Public Service Medal in 2007);
- Development of a microdosimeter instrument, tested aboard the MidSTAR-1 satellite, for real-time personal radiation monitoring, with applications to radiation assessment on Earth;
- Ultrasound training for non-physicians aboard the ISS for health monitoring and medical imaging resulted in a NSBRI/NASA/contractor collaboration leading to the first scientific publication from space,[3] with applications on Earth for remote-guided medical evaluation and sports medicine;
- Development and testing of a high-intensity, focused ultrasound technique for non-invasive, bloodless surgery, with applications in space, emergency rooms and on the battlefield;
- Studies to determine oxygen requirements and means to concentrate oxygen in hypoxic, harsh environments, with applications on Earth to emergency and military medicine.

What role will the International Space Station play in addressing those questions?

While short-duration flights and ground-based research, including the use of analog environments, contribute to biomedical research for space exploration, the ISS provides the only

---

[2] See http://www.nsbri.org/Research/index.html for a complete listing of projects.
[3] *Radiology* 2005; 234(2):319-322.

resource with the capabilities to conduct certain types of research and to advance countermeasures and technologies. There are two immediate strategic goals the ISS can fulfill in the area of biomedical research to address exploration needs. It will serve as a proving ground for scientific and technological product development of deliverables currently in the pipeline. These deliverables may address specific standards and requirements. Secondly, access to the ISS would foster new project opportunities that leverage off the portfolio of projects currently addressing exploration needs.

What is needed to maximize the utility of the International Space Station for conducting the necessary biomedical research?

Affordable and reliable access to and from the ISS is key to the success of conducting the necessary biomedical research. Critical to this access is the availability of cost-effective transportation services.

Given adequate access to and from ISS, it is essential to have a robust management structure and leadership for conducting and integrating science. Research aboard the ISS should be of the highest merit, with ample preliminary work to ensure success. There should be clear justification as to why the ISS is the best, or perhaps only, laboratory to conduct the research. Some biomedical research is fundamental and can only be performed in a microgravity environment. However, much of the necessary biomedical investigations for space are translational. They mature through a pipeline from research, to development, to testing, to evaluation, to operational integration. To maximize the utility of the ISS in this context, it is wise to link the ISS National Laboratory to the full spectrum of space-related research being conducted throughout academia, industry and government.

Lastly, a countermeasure advancement process, developed specifically for utilization of the ISS National Laboratory, would be helpful to facilitate key research moving through the pipeline of development to advance to validation in space. Such a process will require strong program oversight and management rigor to assess the operational need and feasibility of the research, thereby maximizing the return on investment.

What, if any, critical enabling biomedical research for exploration cannot be done on the International Space Station and will have to be addressed by other means?

While many areas of biomedical research for exploration would benefit from access to the ISS, some research is not suitable for ISS and needs to be addressed by other means. Four examples follow:

Radiation Studies – Studies toward countermeasure development against the acute and chronic effects of radiation cannot be fully conducted in low Earth orbit, given the presence of the Van Allen belts. The radiation spectrum beyond low Earth orbit can be emulated utilizing beams of high-energy heavy ions, such as those found at Brookhaven National Laboratory.

Long-duration Exposure to Reduced Gravity - The effects of microgravity on the body during long-duration missions are well documented (e.g., approximately 1% bone loss per month). However, the effects of long-term exposure to reduced gravity are not known. Gravity on the moon is 1/6 of Earth's gravity and on Mars it is 3/8 of Earth's gravity. There are many open questions, such as whether extravehicular activities in these gravitational environments obviate the need for supplemental exercise countermeasures.

Lunar Dust - Dust, such as on the moon, poses an environmental risk that could result in mechanical failures in spacesuits and airlocks. Lunar dust is exceedingly small, making it easy to get deep into the lungs. The dust is littered with bonded shards of glass and minerals known as agglutinates, which have not been found on Earth. It is not known whether they can be expelled efficiently if inhaled.

Medical Emergency Management – Through the use of a high-fidelity patient simulator, astronauts and ground personnel involved in mission operations can practice management of medical emergencies. Ground-based simulation of medical contingencies complements activities to advance medical care capabilities that could be tested and evaluated aboard the ISS.

In closing, as ISS construction nears completion, there is an unprecedented opportunity to conduct biomedical and other research, and to test and validate critical technologies for human exploration of space. This endeavor will be collaborative, international and will advance our nation as we build upon our legacy of innovation, discovery and leadership.

Attachment A

NSBRI Research to pave the way for human exploration of space
National Space Biomedical Research Institute

The National Space Biomedical Research Institute (NSBRI) is a unique, non-profit scientific partnership with NASA committed to implementing the Vision for Space Exploration by providing practical, validated and effective solutions to support and maintain human health and performance during long-duration spaceflight. NSBRI engages academic, industrial and government researchers and educators, and the resources of the nation's leading biomedical research institutions, in a team-based effort to reduce the significant health risks associated with human space travel. The Institute's goal-directed, cost-efficient science, technology and education programs strongly impact both the safety of human space travel and the quality of life on Earth.

Mission

The Institute leads a national effort for accomplishing the integrated, critical path, biomedical research necessary to support the long-term human presence, development, and exploration of space and to enhance life on Earth by applying the resultant advances in human knowledge and technology acquired through living and working in space.

Overview

- **Public-Private Partnership**. NSBRI is a NASA-supported corporation that is responsive to NASA's needs. The Institute draws readily upon competitively-selected resources in universities and industry to address specific problems and provide a targeted, product-oriented research and development program.

- **Countermeasure Production**. Each project is part of an integrated plan to produce enabling technologies and countermeasures. Our directed approach links the knowledge base of academia with the expertise of spaceflight operations to identify, develop and deliver technology and countermeasure strategies that meet the needs of space exploration. The Institute has an Industry Forum to assist with the Earth-based applications of these advances.

- **Prioritized Team Approach**. The Institute is organized into teams that address major physiological or medical issues (e.g. bone loss, muscle alterations, smart medical care). Team efforts are concentrated on overarching programmatic goals for the development of risk-mitigation strategies to support exploration needs. Partnerships within and between teams provide integrated project suites addressing multiple aspects of human health and performance concerns.

- **Operational Focus**. The Institute's User Panel comprised of flight surgeons and astronauts ensures that the deliverables for reducing human risks are focused on operational NASA requirements and support directly the goals of the Vision for Space Exploration. NSBRI can test candidate strategies in analog environments to validate preflight readiness.

- **Strong Program Oversight and Management Rigor**. A Board of Scientific Counselors and an External Advisory Council composed of engineers, physicians and scientists with national and international reputations review progress and provide advice for continued program excellence.

Organization

- NSBRI program involves investigators from more than 70 universities and institutions across the United States.
- National education and outreach activities at all levels.
- Governed by a consortium consisting of Baylor College of Medicine, Brookhaven National Laboratory, Harvard Medical School, The Johns Hopkins University, Massachusetts Institute of Technology, Morehouse School of Medicine, Mount Sinai School of Medicine, Rice University, Texas A&M University, University of Arkansas for Medical Sciences, University of Pennsylvania Health System and University of Washington.
- Productive collaborations between the NSBRI and NASA centers, as well as with international partners, provide the best possible chance of solving complex biomedical problems related to a human presence in space.

For more information, contact:

National Space Biomedical Research Institute
One Baylor Plaza, NA-425
Houston, TX 77030-3498
713-798-7412
www.nsbri.org
info@www.nsbri.org

Attachment B

Published in *Aviat Space Environ Med*. 2008 Apr;79(4):432

AsMA News

Space Medicine Association News

National Space Biomedical Research Institute and Space Medicine

by Jeffrey P. Sutton, M.D., Ph.D.
Director, National Space Biomedical Research Institute

Founded in 1997 through a NASA competition, the National Space Biomedical Research Institute (NSBRI) is a non-profit organization dedicated to advancing biomedical research and space medicine to ensure a safe and productive long-term human presence in space. NSBRI serves a unique role for NASA by engaging and coordinating outstanding investigators and clinicians from across the country to participate in team-based approaches to address high-priority biomedical issues and problems associated with human space missions.

NSBRI leverages the nation's investment in biomedical research and supports projects at approximately 70 universities in 26 states. The Institute also has a nationally acclaimed education and outreach program that provides curriculum guides at the elementary through high school levels, develops web-based resources for teachers and faculty, and coordinates excellent programs at the undergraduate, graduate, postdoctoral, and early-investigator levels. There is also a Continuing Medical Education (CME) program in space medicine sponsored by Baylor College of Medicine, one of the twelve consortium institutions involved in the governance of NSBRI. The CME program operates primarily at NASA-Johnson Space Center, where NSBRI has close ties to NASA scientists, engineers, flight surgeons, astronauts, and management. Activities interfacing NSBRI and NASA are coordinated through a Steering Committee, as well as through other groups involving space medicine personnel.

The science and technology portfolio, education and outreach projects, and other information pertinent to NSBRI can be found at www.nsbri.org. Proposals that engage the academic community, incorporate aerospace physicians and individuals with flight experience, and that address operationally relevant problems are particularly important to NSBRI. These science and technology projects are often interdisciplinary and yield deliverables that mature through a pipeline spanning research, development, testing, evaluation, and operational integration.

To help ensure that NSBRI meets its missions to 1) lead a national effort for accomplishing the biomedical research necessary to support the long-term human presence in, and development and exploration of space, and 2) enhance life on Earth by applying the resultant advances in human knowledge and technology, the Institute has an active User Panel comprised of current and former astronauts and flight surgeons. Leroy Chiao, Ph.D., a veteran of four space missions, including the command of Increment 10 of the International Space Station, chairs the Panel. Jonathan Clark, M.D., past president of the Space Medicine Association, is also on the Panel and additionally serves the Institute as NSBRI/NASA Space Medicine Liaison.

The majority of science and technology projects and educational opportunities are solicited through open announcements, released either by NSBRI alone or jointly with NASA. The solicitations typically occur annually and are posted on the NSBRI and NASA websites. Some projects are acquired through directed tasks, generally from NASA. All projects, regardless of acquisition mechanism, undergo peer review and are vetted through oversight councils prior to selection.

Funded science and technology projects are assigned to 1 of 10 teams in the following areas: Bone Loss; Cardiovascular Alterations; Human Performance Factors, Sleep and Chronobiology; Muscle Alterations and Atrophy; Neurobehavioral and Psychosocial Factors; Nutrition, Physical Fitness and Rehabilitation; Radiation Effects; Sensorimotor Adaptation; Smart Medical Systems; and Technology Development. Each team is under the leadership of a nationally recognized expert in science, medicine, and/or engineering. NSBRI management and NSBRI/NASA liaisons work with investigators, team leadership, and NASA to facilitate progress and maturation of deliverables. Projects are often funded for 4 yr and are competitively renewable.

In addition to supporting top-tier academic investigators and teams to work on high-priority biomedical problems, and to develop countermeasures to reduce risks inherent with human spaceflight, NSBRI has expanded its connections to industry and the international community. Approximately 40 companies are now strategically linked to the Institute, and there has been considerable growth in science and education efforts through international collaborations. The Institute is a success story for NASA and a model for how a national translational research program can run in a productive and cost-effective manner.

NSBRI welcomes inquiries and suggestions from the Aerospace Medical Association membership and affiliates. The Institute adds demonstrable value to the NASA Human Research Program and is well positioned to make further positive contributions in important areas interfacing aerospace and medicine. For more information, visit us at www.nsbri.org or contact us as info@nsbri.org.

Attachment C

NSBRI Board of Directors

NSBRI Chairman and CEO
Bobby R. Alford, M.D.
Baylor College of Medicine

William L. Allen
National Geographic Magazine (ret.)

Carl W. Anderson, Ph.D.
Brookhaven National Laboratory

James B. Bassingthwaighte, M.D., Ph.D.
University of Washington

MajGen. Charles F. Bolden, Jr., USMC (ret.)
Former Astronaut

Joseph V. Bonventre, M.D., Ph.D.
Harvard-MIT Division of Health Sciences and Technology
Harvard University

James S. Coleman, Ph.D.
Rice University

Peter F. Davies, Ph.D.
University of Pennsylvania Health System

Michael E. DeBakey, M.D.
Baylor College of Medicine

Theresa W. Fossum, D.V.M., Ph.D.
Texas A&M University

Glen N. Gaulton, Ph.D.
University of Pennsylvania Health System

Martha L. Gray, Ph.D.
Harvard-MIT Division of Health Sciences and Technology
Massachusetts Institute of Technology

Sandra A. Harris-Hooker, Ph.D.
Morehouse School of Medicine

Fritz A. Henn, Ph.D., M.D.
Brookhaven National Laboratory

Eve J. Higginbotham, M.D.
Morehouse School of Medicine

Richard J. Johns, M.D.
The Johns Hopkins University

Kristina M. Johnson, Ph.D.
The Johns Hopkins University

Eugene H. Levy, Ph.D.
Rice University

Robert E. McGehee, Jr., Ph.D.
University of Arkansas for Medical Sciences

Larry D. Milne, Ph.D.
University of Arkansas for Medical Sciences

Warren Olanow, M.D.
Mount Sinai School of Medicine

John A. Parrish, M.D.
Harvard Medical School

Hon. John E. Porter
Partner, Hogan & Hartson LLP

Alan L. Schiller, M.D.
Mount Sinai School of Medicine

Jeffrey A. Simmen, Ph.D.
University of Washington

David R. Strome, Ph.D.
Wyle Laboratories

Peter G. Traber, M.D.
Baylor College of Medicine

Secretary/Treasurer
Cyndi M. Baily
Baylor College of Medicine

Ex Officio
Stephen B. Doty, Ph.D.
Hospital for Special Surgery
NSBRI External Advisory Council Chairman

Ex Officio
Jeanne L. Becker, Ph.D.
NSBRI Associate Director

Ex Officio
Jeffrey P. Sutton, M.D., Ph.D.
NSBRI Director

Director Emeritus
Joseph P. Kerwin, M.D.
Wyle Laboratories (ret.)

Director Emeritus
J. David Litster, Ph.D.
Massachusetts Institute of Technology

Director Emeritus
Arnold N. Weinberg, M.D.
Massachusetts General Hospital

Director Emeritus
Torsten N. Wiesel, M.D.
Rockefeller University

Attachment D

NSBRI User Panel

The User Panel, comprised of former and current astronauts and flight surgeons, ensures the NSBRI research program is focused on astronaut health and safety.

Leroy Chiao, Ph.D.
Chairman
Former Astronaut

Ellen S. Baker, M.D.
NASA-Johnson Space Center
Astronaut

Daniel W. Bursch
Former Astronaut

Eileen M. Collins
Former Astronaut

Walter Cunningham
Former Astronaut

J.M. "Mike" Duncan, M.D.
NASA-Johnson Space Center
Flight Surgeon

David Hilmers, M.D.
Baylor College of Medicine
Former Astronaut

Thomas Jones, Ph.D.
Former Astronaut

Joseph P. Kerwin, M.D.
Former Astronaut

Richard M. Linnehan, D.V.M .
NASA-Johnson Space Center
Astronaut

Shannon Lucid, Ph.D.
NASA-Johnson Space Center
Astronaut

J.D. Polk, M.D.
NASA-Johnson Space Center
Flight Surgeon

Richard A. Scheuring, D.O.
NASA-Johnson Space Center
Constellation Medical Operations
Flight Surgeon

Donald A. Thomas, Ph.D.
Former Astronaut

James S. Voss
Former Astronaut

Executive Secretary
Jonathan B. Clark, M.D.
NSBRI/NASA Space Medicine Liaison