Medical Policy Board Handbook

NASA Headquarters

AM/Office of the Chief Health and Medical Officer

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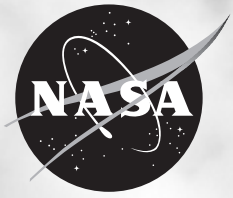
November 30, 2000



Medical Policy Board Handbook

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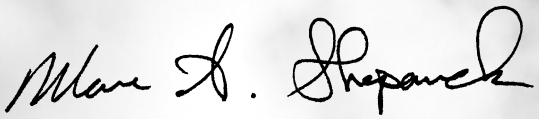
prepared by:



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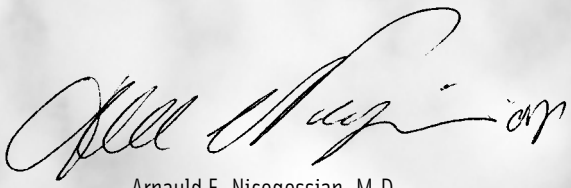

Arnauld E. Nicogossian, M.D.
Chair, Medical Policy Board

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National Aeronautics and
Space Administration

Acronym List

AA Associate Administrator
AMB Aerospace Medicine Board
AMD Aerospace Medicine Division

CBRF Change Board Request Form
CHMO Chief Health and Medical Officer

ESA European Space Agency
EVA Extravehicular Activity

HEDS Human Exploration and Development of Space
HQ Headquarters

ISS International Space Station

JEM Japanese Experimental Module
JSC Johnson Space Center

MPB Medical Policy Board
MPBH Medical Policy Board Handbook
MOB Medical Operations Branch
MOSIP Medical Operations Support Implementation Plan

NASA National Aeronautics and Space Administration
NMI NASA Management Instruction
NPC NASA Policy Charter
NPD NASA Policy Directive
NPG NASA Procedures and Guidelines
NSTS National Space Transportation System

OAST Office of Aerospace Technology
OHSEB Occupational Health and Safety Executive Board
OBPR Office of Biology and Physical Research
OSF Office of Space Flight

PCN Page Change Notice
PHPC Permanent Human Presence Capability
PMC Private Medical Conference

RASA Russian Aviation and Space Agency

SMA Safety and Mission Assurance
STS Space Transportation System

preface

This document, prepared by the NASA Medical Policy Board (MPB), describes medical and clinical policies and related procedures for human space missions. The appendices, which appeared in earlier versions, have been updated.

This revision reflects changes in NASA's medical policy for strategic planning and references an increased knowledge in evidence-based space medicine gained from the ongoing human space flight program. The Top Ten Health and Medical Issues for Aerospace Medicine is a living document, continuously updated, to reflect the requirements of current and future space missions. It is used consistently in documents ranging from strategic plans to Congressional testimony to the JSC critical path.

Based on the availability of new information, periodic updates to this document will be made. At a minimum, MPB will conduct reviews of this document on on an annual basis. Changes to the contents of this document can only be made following approval by MPB.

Arnauld E. Nicogossian, M.D.
Chair, Medical Policy Board

Medical Policy Board Membership

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  Office of the Chief Health and Medical Officer
- Executive Secretary – Deputy Chief Health and Medical Officer
  Office of the Chief Health and Medical Officer

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- Medical Service Officer

Dryden Flight Research
- Chief, Aerospace Medicine

Johnson Space Center
- Director, Space and Life Sciences Directorate (ex-officio)
- Assistant Director, Space and Life Sciences Directorate
- Assistant Director, Space Medicine, Space Life, and Sciences Directorate
- Chief, Medical Operations Division
- Physician Astronaut, Astronaut Office

Kennedy Space Center
- Chief Medical Officer, Kennedy Space Center
- Manager, Agency Occupational Health
- Medical Officer, Occupational Health Office

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- Director, National Institute of Deafness and Other Communications Disorders
- Chairman, Department of Preventive Medicine and Biometrics, Uniformed Services University of the Health Sciences
- Director, Center for Quality Measurement and Improvement, Agency for Health Care Policy and Research
- Chief of Medical Standards, U.S. Air Force

Consultants

NASA Headquarters
- Acting Associate Administrator, Office of Biological and Physical Research (ex officio)
- Aerospace Medicine Specialist, Office of the Chief Health and Medical Officer

Medical Policies Board Handbook

1.0 Purpose

The purpose of this document is to serve as a guide for medical personnel at NASA to:

- Baseline medical policies relevant to NASA-sponsored and NASA actions in support of national and international missions involving humans;
- Provide a process for the review and acceptance of medical requirements and deliverables for human space flight;
- Provide for the application of clinical and ethical best practices in space medicine;
- Address policies and requirements relevant to the medical care of illness and injury in flight and resulting from space flight, and the overall practice of medicine; and
- Provide a process for the review and approval of deliverables resulting from crew health research prior to the delivery to the general community for final testing and implementation.

2.0 Scope

The policies outlined within this document are applicable to all medical operations in support of human space flight.

3.0 Authority

This document is controlled by the Chair of the Medical Policy Board (MPB) at NASA Headquarters. Requests for revisions to the Medical Policies Document (MPD) are made through the submission of the Change Board Request Form (CBRF) (Appendix 1). Revisions approved by the MPB Chair will be made by Page Change Notices (PCN).

The MPB was established under NASA Policy Charter (NPC) 1152.76, NASA Medical Boards in Support of Space Flight Operations. This MPBH supports the MPB and is under the authority of this NPC. In addition, NASA Policy Directive (NPD) 8900.1E, Medical Operations Responsibilities for Human Space Flight Programs, designates Johnson Space Center (JSC) as the responsible center for medical operations activities in support of human space flight. NASA NPDs are supported by NASA Procedures and Guidelines (NPGs), which provide implementation procedures and guidelines for the respective policies.

4.0 Applicable Documentation

Documentation Tree

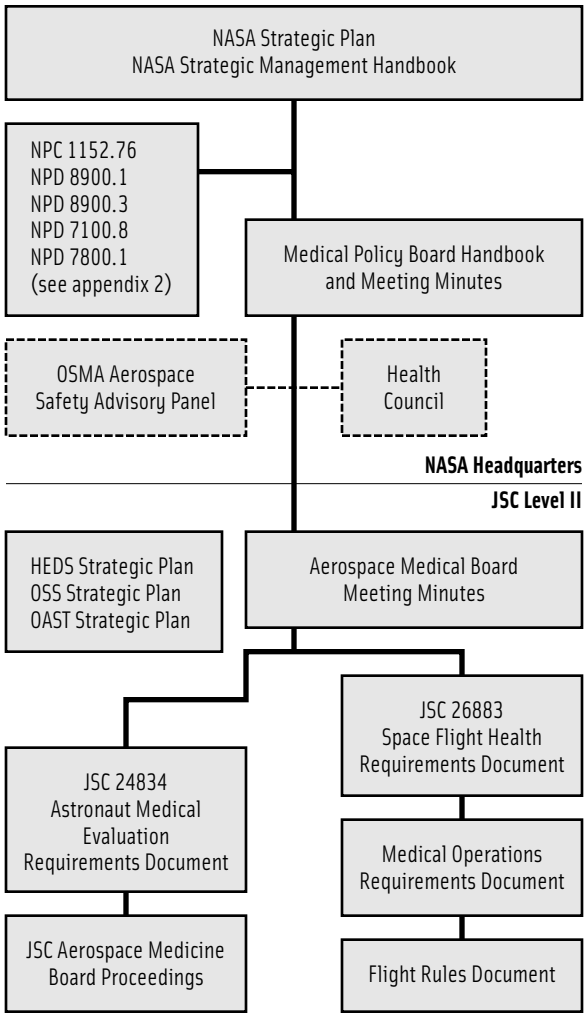


Figure 1 illustrates how documentation that supports medical policy flows from the Agency's strategic plans to the MPB handbook and minutes, as well as the supporting documentation to the lead center for space medicine at JSC. Appendix 2 lists other pertinent documentation that supports the implementation of medical operations.

5.0 Background

In 1977, NASA established two medical boards, the MPB and the Aerospace Medicine Board (AMB), to address space crewmembers' medical selection and retention standards, provide for medical certification for flight duties, issue medical waivers, and recommend special studies to be undertaken in support of human space flight. NASA's Chief Health and Medical Officer (CHMO), Office of the Administrator (Code AM), serves as the Chair of MPB. A Senior Medical Officer at JSC is the Chair for AMB.

The Agency's activities and long-term goals are focused in five enterprises:

- Human Exploration and Development of Space (Code M)
- Aerospace Technology (Code R)
- Space Science (Code S)
- Biological and Physical Research (Code U)
- Earth Science (Code Y)

The Office of Space Flight (Code M) and the Office of Biological and Physical Research (Code U) at NASA Headquarters have major responsibilities in astronaut health. OSF has the overall management responsibility for all mission development and operations involving human crews, including operational space medicine. Code U, Code R, and Code S are responsible for the conduct of research and technology development to ensure crew health and well-being. The Office of the Chief Health and Medical Officer (CHMO) provides recommendations for medical policy to the NASA Administrator and oversight for crew medical support. Code AM is responsible for all Agency medical and health policies and the review of requirements generated by Code M and health-related research deliverables produced by Code U, Code R, and Code S. The Office of Safety and Mission Assurance is concerned with crew and personal safety. The Office of Space Science (Code S) is responsible for robotic missions which provide information on environmental conditions on bodies other than earth, and astro-biology.

Table 1

Medical Events in Shuttle Program Reported by Frequency from Postflight Medical Debrief, STS-26–STS-74 (1988–1995)

Condition	Frequency	Percent
Facial fullness	226	81.0%
Headache	212	76.0%
Sinus congestion	173	62.0%
Dry skin, irritation, rash	110	39.4%
Eye irritation, dryness, redness	64	22.9%
Foreign body in eye	56	20.1%
Sneezing/coughing	31	11.1%
Sensory changes (e.g., tingly, numbness, unusual sensations)	26	9.3%
URI (common cold, sore throat, sinus headache, hayfever)	24	8.6%
Back muscle pain (excluding "space" backpain)	21	7.5%
Leg/foot muscle pain	21	7.5%
Cuts	19	6.8%
Shoulder/trunk muscle pain	18	6.5%
Hand/arm muscle pain	15	5.4%
Anxiety/annoyance	10	3.6%
Contusions	10	3.6%
Ear problems (predominantly earaches)	8	2.9%
Neck muscle pain	8	2.9%

Table 1, continued…

Condition	Frequency	Percent
Stress/tension	8	2.9%
Muscle cramp	7	2.5%
Abrasions	6	2.2%
Fever, chills	6	2.2%
Nosebleed	6	2.2%
Psoriasis, folliculitis, seborrhea	6	2.2%
Low heart rate	5	1.8%
Myoclonic jerks (associated with sleep)	5	1.8%
General muscle pain, fatigue	4	1.4%
Subconjunctival hemorrhage	4	1.4%
Allergic reaction	3	1.1%
Fungal infection	3	1.1%
Hoarseness	3	1.1%
Concentrated or "dark" urine	2	0.7%
Decreased concentration	2	0.7%
Dehydration	2	0.7%
Inhalation of foreign body	2	0.7%
Subcutaneous skin infection	2	0.7%
Chemical in eye (buffer solution)	1	0.4%
Fever blisters	1	0.4%
Mood elevation	1	0.4%
Phlebitis	1	0.4%
Viral gastrointestinal disease	1	0.4%

Table 1: Medical Events in Shuttle Program Reported by Frequency from Postflight Medical Debrief, STS-26 Through STS 74 (1988–1995). JSC Publication (EDO Report?)

Table 2

In-flight Medical Events for Cosmonauts in MIR Program from February 7, 1987 to February 29, 1996

Medical Event	Initial Events (n=169)	Recurrences (n=135)
Superficial injury	34	2
Arrhythmia/conduction disorder	30	98
Musculoskeletal	29	NR
Headache	16	8
Sleeplessness	10	9
Tiredness	10	4
Conjunctivitis	4	2
Contact dermatitis	4	3
Erythema of face, hands	4	NR
Stool contents (preflight)	4	NR
Acute respiratory infection	3	NR
Asthenia	3	2
Surface burn, hands	3	NR
Dry nasal mucous	2	NR
Glossitis	2	1
Heartburn/gas	2	NR
Foreign body in eye	2	NR
Constipation	1	NR
Contusion of eyeball	1	NR
Dental caries	1	NR
Dry skin	1	1
Hematoma	1	NR
Laryngitis	1	5
Wax in ear	1	NR

NR = None Reported

Table 2: In-flight Medical Events for Cosmonauts in MIR Program February 7, 1987 to February 29, 1996. JSC Publication (reference)

The policies outlined in this document, to the extent possible, are founded on evidence-based medicine as well as data available from previous space flights. Table 1 is Medical Events in Shuttle Program Reported by Frequency from Postflight Medical Debrief, STS-26 Through STS 74 (1988-1995). Table 2 is In-flight Medical Events for Cosmonauts in MIR Program from February 7, 1987 to February 29, 1996. Table 3 is Illness and Injury in Antarctica 1988–1997. Table 4 is Physiological Response to Isolation and Confinement in Antarctica. Much of the experience in space flight is also cataloged in the Longitudinal Studies of Astronaut Health database. As appropriate, analog populations are studied (both retro- and prospectively) to further understand the risk, establish appropriate training, and prepare an appropriate health care plan for the medicine and psychology of extreme environments.

Table 3

Illness and Injury in Antarctica 1988–1997

Group	Number of Cases	Percent
Injury and Poisoning	3910	42.0%
Respiratory system	910	9.7%
Skin and subcutaneous tissue	899	9.6%
Nervous system and sense organs	702	7.5%
Digestive system	691	7.4%
Infections and parasitic disease	682	7.3%
Musculoskeletal and connective tissue	667	7.1%
Symptoms ill defined	335	3.6%
Mental disorders	217	2.3%

Table 3: Illness and Injury in Antarctica 1988–1997. Group categories based on International Classification of Diseases, Ninth Revision.Approximately 359 additional cases in 8 groups with each group being less than 1.5 percent. Lugg, D.J. Antarctic Medicine. JAMA 283(16):2082-2084, 2000.

Table 4

Physiological Response to Isolation and Confinement in Antarctica

▲ weight
- ▲ lipids
- ▲ blood pressure

Immune function
- delayed reactivity to bacteria
- ▲ virus shedding
- ▼ T-cell function

Thyroid function
- ▲ TSH
- ▲ T3 production/clearance

▼ hydroxylation of vitamin D (▼ UV-B radiation)
- ▲ PTH
- ▼ testosterone

Table 4: Physiological Response to Isolation and Confinement in Antarctica. Gleeson, M.; Francis, J.L.; Lugg, D.J.; Clancy, R.L.; Ayton, J.M.; Reynolds, J.A.; McConnell, C.A. A year in Antarctica: mucosal immunity at three Australian stations. Immunology and Cell Biology (in press). Shearer, W.T.; Lugg, D.J.; Rosenblatt, H.M.; Nickolls, P.M.; Sharp, R.M.; Reuben, J.M.; Ochs, H.D. Antibody responses to the bacteriophage phi chi-174 in humans exposed to the Antarctic winter-over model of space flight. Journal of Allergy and Clinical Immunology (in press).

In addition to the monitoring done in conjunction with preventive medicine and clinical care efforts, a baseline (Earthbound and once in space flight) profile is established for each crewmember in terms of metabolic and endocrine function and acid-base balance. This baseline is re-established periodically, as clinically indicated.

In support of the Administrator's focus on safety the MPB will work closely with the NASA Health Council, NASA Occupational Health Program, and other Agencies.

5.1 Elements of the Space Medicine Program

Space flight induces two types of changes in the body's systems: adaptive and pathophysiological. Infrequently, medical events occur that require treatment which can affect mission success. The common elements of medical programs developed by NASA and Russia (Ministry of Health and Air Force) are:

- **Astronaut/cosmonaut medical selection and retention standards**: To assure that individuals are healthy and to ensure career longevity. Periodic medical evaluations rely on the accepted ground-based standards of preventive medicine, health maintenance, and medical practice. These standards are revised on a periodic basis to ensure that they are fair and appropriate to meet the needs of human space flight.

- **Special medical procedures and tests:** Based on the knowledge of specific health risk factors associated with space flight, appropriate and proven tests may be utilized in selection and periodic evaluations and may be used prior to ground training or during missions.

- **Annual medical evaluations:** These are performed to identify and correct medical risks to maintain health, provide certification for flight duties, and ensure career longevity.

- **Preflight:** The primary emphasis of medical support preflight is on prevention. The Crew Health Stabilization Program is designed to protect the crew from exposure to contagious disease prior to flight. Crewmembers are trained in the use of special countermeasures to space flight physical deconditioning and in medical monitoring and clinical practice procedures. Medical training for the crew; medical supervision of mission planning, schedules, payloads, exercise training, and conditioning, etc.; and other health maintenance activities are part of the preflight period.

- **In flight:** The primary emphasis of in-flight medical support is on health maintenance. Health monitoring and medical intervention, countermeasures to deconditioning, and environmental monitoring enable a comprehensive program tailored to crew and mission needs and for the periodic assessment of crew medical status, including the identification of potential and unexpected health risks.

- **Postflight:** The primary emphasis of postflight medical support is medical care. Health monitoring and physical rehabilitation are performed to accelerate the return of crewmembers to normal Earth-based duties.

5.2 Medical Standards

NASA operational medicine policies and standards are evaluated and approved by MPB. In the United States, medical standards for the selection of astronauts and for annual examinations were introduced in 1978. These standards are periodically reviewed (at least every 5 years) to assure compliance with accepted practices of medicine in the United States. With the advent of increased international cooperation, attention is being placed on the cross-cultural approaches to medical care.

NASA medical standards may be used as the basis for formulation of international standards in support of international space flight missions as long as such joint standards are consistent with the MPB policies and in compliance with accepted practices of medicine in the United States to the extent allowed by mission constraints.

5.3 Definition of Terms

The following definitions applicable to Space Medicine are provided for clarification.

- **Adaptation** – Defined as physical, physiological, or psychological changes and modifications that enable individuals or groups to survive in a given extreme environment. These changes can be induced either through exposure to the environment or as the result of applications of technology. For the purpose of space flight, adaptation occurs

in the average period of time required to achieve a new physiological or psychological equilibrium. Adaptation, as a physical, physiological, or psychological process or period will vary among individuals and different body systems. Technology, isolation, and confinement and other environmental factors will affect the time frame and outcomes related to the physiological or psychological changes.

- **Mission Duration** – Based on physiological changes from Earth baseline, it refers to: 1) short duration missions defined as less than or equal to four weeks, and 2) long duration missions more than four weeks.

- **Monitoring** – Periodic clinical evaluations or observations of health trends to detect unexpected medical or psychological risk requiring timely intervention.

- **Countermeasures** – Refers to the application of procedures or therapeutic (physical, chemical, biological, or psychological) means to maintain health, reduce risk, and improve the safety of human spaceflight.

- **Levels of prevention:**

  - **Primary Prevention** – eliminating or preventing adverse and harmful effects on crew health. Examples include: (1) the Crew Health Stabilization Program and immunizations to protect against infections; (2) preflight medical and psychological exams to identify and correct risks; (3) provision of a gravitational substitute effect on orbit, preventing microgravity from degrading the health of the astronauts; and (4) providing a safe and healthy environment in space mission habitats using proper systems engineering processes and technology.

  - **Secondary Prevention** – mitigating the effect of adverse or harmful agents or enhancing the astronaut's ability to ward off the effects of these agents. Examples include: preflight and in-flight exercise to counteract the effects of microgravity, in-flight administration of medications to prevent space motion sickness, spacecraft design changes to minimize radiation exposure, and design of human machine interfaces or work schedules to maximize data comprehension or physical control of a robotic arm.

  - **Tertiary Prevention** – minimizing the effect of adverse or harmful agents on the crew once maladaptation, disease, or injury has been identified. Examples include: fluid loading to minimize orthostatic intolerance, or a postflight rehabilitation program for space mission induced musculoskeletal deconditioning, cardiovascular reconditioning, or space radiation exposure.

6.0 Process and Interface with NASA Organizations

Code M, the Office of Space Flight (Human Exploration and Development of Space), Code Q (Safety and Mission Assurance), and Code AM, the Office of the Chief Health and Medical Officer in the Office of the Administrator, are the Headquarters organizations responsible for the processes to support astronaut and cosmonaut health and safety. The Office of the Chief Health and Medical Officer is responsible for NASA medical policy and oversight for medical support for space missions, including oversight of clinical support, review and validation of health-related requirements, and review of health-related research, such as the establishment of milestones and deliverables in support of crew health.

The Office of Space Flight (OSF), Code M, the Human Exploration and Development of Space Enterprise, is responsible for the overview of health and medical care to space mission crews and for defining, developing, and prioritizing health and medical requirements.

Code U, the Office of Biological and Physical Research, is responsible for conducting research to ensure the health, safety, and performance of humans living and working in space and is specifically responsible for developing research priorities, research solicitation, peer review, funding of proposals, and dissemination of research results.

Code Q is responsible for overall mission safety including the Aerospace Safety Advisory Panel (ASAP). Figure 2 illustrates the requirements development process.

The Office of Space Flight, Code M, develops requirements through the flight surgeons, based on input from the astronauts and cosmonauts, which are delivered to the Chief Health and Medical Officer in the Office of the Administrator.

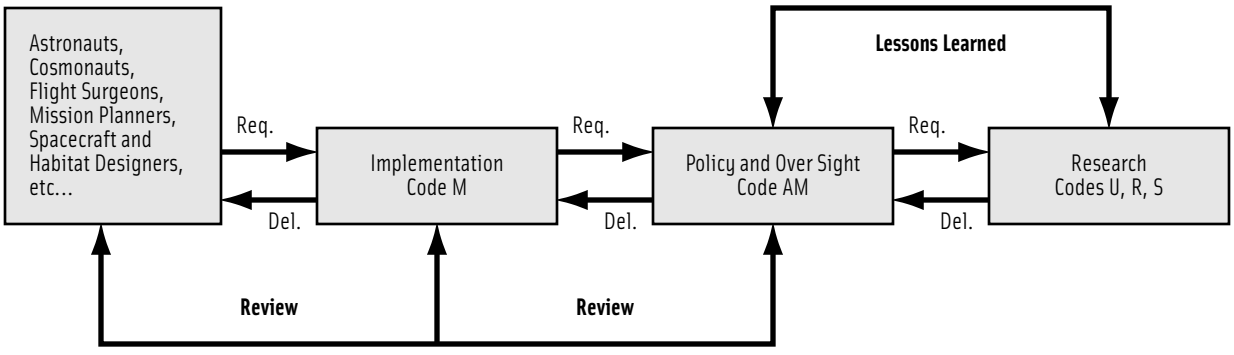
The Office of the Chief Health and Medical Officer validates and transmits requirements on to the research codes–Code U (Biological and Physical Research), Code S (Space Science), and Code R (Aerospace Technology), who develop research questions; solicit, fund, and oversee research; and provide deliverables to the Office of the Chief Health and Medical Officer for review and approval. The product generated as a result of research is then field-tested by Code M, followed by the Space and Life Sciences Directorate at JSC. The JSC team develops and recommends to MPB, via a CBRF, policies and standards. In performing this evaluation, JSC uses intramural, extramural, national, and international consultants, as well as results from safety and quality assurance reviews. Following MPB approval, JSC's recommendations are transmitted to the program offices for the Space Shuttle and ISS.

6.1 Process for Developing Space Flight Health-Related Policies

MPB is responsible for reviewing proposed policies concerning crew health. This is done via ongoing activities of MPB and through policy statements found in this document. Requirements documents regarding the interpretation and application of MPB policies, as well as working-level documents discussing detailed implementation methodologies, protocols, flight rules, etc., are the responsibility of Medical Operations at JSC and HEDS. Areas processed under this system include: preventive medicine and health activities, environmental health, medical treatment, countermeasure efficiency, therapeutic and surgical interventions, and policies formulated as appropriate.

Figure 2.

Health and Medical Requirements and Deliverables Development Process



MPB membership considers the following guidelines in the development of policies:

- The adequacy of available information to predict and measure the magnitude of health risk(s) from exposures (space missions) as a whole and by individual body systems.
- The extent and type of health monitoring required to establish the efficiency and potential side effects of the prescribed countermeasure(s).
- The extent to which health monitoring is required to guide the physical rehabilitation efforts in flight and during the post-mission periods.
- The research priorities and available resources for resolving pressing operational issues.

7.0 MPB policy statements

7.1 General policy statements

The first and foremost goal of NASA's Chief Health and Medical Officer is a healthy NASA workforce on the ground, in the air, and in space. One of the major goals of NASA's Health Programs is to ensure that necessary procedures and protocols for space mission crew health maintenance and care (preflight, in flight, and postflight) are developed, validated, and implemented. These procedures should conform to established best medical practices as they apply to space missions.

7.1.1 Health Maintenance Criteria

To ensure the safety of the crew as well as mission completion, the following medical and psychological performance criteria were established:

- Ability to function as a productive member of the flight crew and perform assigned duties,
- Ability to maintain adequate orthostatic tolerance during deorbit, entry, and landing,
- Ability to execute a contingency egress from spacecraft after short space flights, and
- Absence of persistent lasting ill health effects from space flight.

7.1.2 Rationale for Selection of Monitoring and Countermeasure Modalities

Exposure to microgravity and the space environment has important medical and health implications, including bone loss (matrix and minerals), increased cancer risk from space radiation, neurovestibular changes, orthostatic hypotension, etc. Because of mission costs and the risks inherent in human space flight, as well as other factors, it is imperative that crewmembers function at peak performance levels at all times. Crewmembers must remain physically and mentally healthy and physiologically capable of performing all mission tasks. The flight deck crew (for U.S. Space Shuttle missions) must be able to maintain orthostasis and perform the critical operations required to fly the Shuttle, while sitting upright, during entry. All crewmembers, returning from short duration space flight, should be capable of egressing the spacecraft unaided in an emergency. In addition, astronauts must have career longevity, normal life expectancy, with recovery, rehabilitation, and repair capabilities available upon their return from space flight. For these reasons, we must be able to provide preventive measures, monitor the health of the crew both on the ground and in flight (human performance and environmental effects are evaluated periodically by monitoring both the sustained physiological changes during space flight and the spacecraft environment), provide appropriate medical care when needed, and develop/validate effective countermeasures to prevent or ameliorate the debilitating effects of exposure to space missions.

7.1.3 Improvement Process

The NASA's health program shall provide mechanisms and processes for the continual improvement and updating of its health-related standards, requirements, rules, and protocols. This process shall be responsive to changing mission scenarios, evolving clinical standards, advances in medical technology, and space flight "lessons learned." A program of space medical epidemiology, analog population studies, longitudinal studies, and operational clinical outcomes shall be part of this process and provide a basis for measuring progress.

7.2 Medical Evaluation, Monitoring, and Certification

7.2.1 Medical standards shall be established and periodically reviewed for the selection, annual certification, and pre- and postflight certification of astronauts. Standards are established by NASA medical policy boards as described in NPD 1152, NASA Medical Boards in Support of Space Flight Operations.

7.2.2 Based on medical standards, a program of health monitoring shall be established in conjunction with the medical certification program to accomplish the following:

- Periodic clinical evaluation of astronaut health,
- Outcome monitoring subsequent to prevention and/or clinical intervention, and
- Establishment of astronaut population health norms.

Planned physical and psychological health monitoring modalities and responses to countermeasures may be conducted at regular intervals for new astronauts (at a minimum of three times), in conjunction with the physical health evaluations prior to the first mission, to establish a baseline normative database against which postflight recovery will be implemented and evaluated. During subsequent missions, depending on the clinical judgment of the crew surgeon, only select protocols might be implemented if adequate baseline data already exist. In the postflight phase, guided by clinical manifestations and physical evaluations, only those protocols will be implemented that are required for diagnostic purposes or to guide the rehabilitation process and the return to flight duties.

While on space missions, crews may undergo full evaluation of the physical and psychological response to those missions and countermeasures, on a monthly basis, to adjust the health maintenance program and prepare for their health care and reintegration to life on Earth upon their return.

7.2.3 Medical monitoring during unique or potentially hazardous activities shall be accomplished and include EVA-activities upon return from long duration space flight.

7.2.4 Periodic medical monitoring shall be performed in the areas of behavioral health and physical fitness for human safety and to accomplish mission goals.

7.3 Medical Intervention and Care Criteria in Low-Earth Orbit Operations

The level of medical care for a given mission shall be established through a health risk management process that balances optimal medical care possibilities against mission and program constraints. Comprehensive medical care is required before, during, and after space flight and must meet the following general criteria:

- Be able to treat crewmembers for a wide range of illness, injury, toxic exposure, or psychosocial problems and return them to effective duty.
- Maximize the chance of mission completion or successful elective return.
- Minimize the impact of a crewmember's illness or injury to any other crewmember.
- Provide for stabilization and timely evacuation of an injured or ill crewmember to a definitive care facility without affecting the safety of the rest of the crew.
- Appropriate medical hardware, procedures, and protocols to support cardiopulmonary and trauma life support shall be available as required for specific flights; appropriate diagnostic and treatment systems which are commensurate with assigned risk category shall also be provided, including sufficient research subject treatments for flight experiments.
- Postflight health rehabilitation shall be provided in order to assist the astronaut for a returning to functional baselines in the areas of physical, physiological, and behavioral health.
- Medical care shall be provided during astronaut training and deployment as indicated by the health risks associated with the activity.
- Emergency life support capabilities, cleanup, and decontamination systems will be provided for hazardous (chemical or bacteriologic) exposures. There will be plans for crewmember protection and treatment and module control in the event the environment becomes contaminated.
- Crewmember treatment with respect to decompression sickness will be provided for at a level comparable to

Earth-based standards within mission constraints.
- Exploration-class missions will require autonomous medical support capability on the mission due to large distances, difficulty of abort scenarios, and communications issues, including time lag and blackout periods.

Rationale for Selection and Implementation of Medical Care Modalities

For space flight missions, emphasis is not only on health maintenance, disease prevention, and environmental issues, but also on the provision of medical care to manage expected and possible illnesses and injuries.

7.4 Environmental Health

A program of Environmental Health support shall be provided that establishes, updates, and monitors space flight parameters and standards for air, water, microbiology, toxicology, radiation, noise, acceleration, and habitability.

7.4.1 A comprehensive, in-flight environmental monitoring system for monitoring the following environmental attributes shall be available: (1) crew exposure to toxicological and microbial contamination of internal air, water, and surfaces; (2) crew exposure to radiation sources from within and external to the spacecraft regardless of the location of the crew (IVA or EVA); and (3) crew exposure to vibration and noise. This system and its components shall have near real-time and archival sampling, and provide a mechanism to alert crewmembers when measured values are outside acceptable limits.

Spacecraft Habitability: Habitability of spacecraft is vitally important to crew health, well being, and productivity, especially as mission duration increases. Habitability issues regarding human presence in space shall include: 1) human factor design considerations (colors, equipment layout, and hardware design); 2) adequate and ergonomically correct work and living volume; 3) adequate lighting; 4) adequate areas that allow for restful sleep and personal space; 5) exterior views; 6) environmental controls for temperature, humidity, noise, and odors; 7) productive, interesting work schedules that are not excessively demanding; 8) scheduling sufficient rest and recreation periods; 9) healthy, palatable variety of food and beverage; 10) private time and physical space; 11) time and resources for personal hygiene; and 12) adequate stowage. Additionally, attention shall be given to individual crewmember preference with regard to palatability and nutritional adequacy of food stuffs during missions. Medical and psychological personnel shall have an opportunity to review all design considerations early in the design process to ensure that spacecraft design and support systems meet medical and psychological requirements.

7.5 Medical Management and Training

7.5.1 Provisions shall be made for emergency medical services in support of launch and landing, crew training, and deployment. Medical support shall be provided throughout all mission phases including mission planning, payloads, and safety reviews and mission control center operations. Appropriate medical and psychological training shall be provided for crewmembers and support personnel. Appropriate portable trainers/simulators to perform routine procedures will be available to crews for onorbit training.

7.5.2 Each crewmember shall receive appropriate baseline medical training and certification, including proficiency training prior to flight, and continuing medical education and training in flight. The nature and schedules of this training may vary with mission needs and available hardware.

7.6 Preventive Medicine and Countermeasures

A program of preventive medicine, including behavioral and performance factors, and countermeasures shall be established and updated based on latest lessons learned, current standards of medical practice, risk management data and expert (intramural and extramural) recommendations. The preventive medicine program shall include all mission phases and target physiologic and behavioral and performance systems at risk. Preflight countermeasures shall include activities to support appropriate crew selection and psychological training, fitness and exercise, physiological adaptive training, health stabilization program, and circadian shifting. In-flight countermeasures shall include those activities necessary to maintain physiologic balance and health, mental and behavioral health, nutritional health, and physical fitness and mission performance. Postflight countermeasures shall include

those activities necessary to assist the crewmembers in a return to preflight physical, physiological, and behavioral health baselines. Examples of countermeasures include but are not limited to circadian rhythm shifting, estrogen replacement, and physical exercise.

- Rationale for Selection and Monitoring and Countermeasure Modalities for Exploration-Class Missions

In development, dependent on resolutions to Top Ten Health and Medical Issues for Aerospace Medicine.

Appendix 1

Medical Policy Board Change Board Request Form

Medical Policy Board
CHANGE BOARD REQUEST FORM

01. Topic:

02. Category:

Monitoring	Countermeasures	Hardware	Research	Vehicle	Priority
☐ Crew Health	☐ Preflight	☐ Crew Equipment	☐ Physiology	☐ STS	☐☐☐
☐ Environment	☐ In Flight	☐ Medical Equipment	☐ Clinical	☐ Spacehab	☐☐☐
☐ Duty Certification	☐ Postflight	☐ Crew Support		☐ ISS	☐☐☐
				☐ Other	☐☐☐

03. Schedule: ☐ Preflight ☐ In Flight ☐ Postflight

04. Purpose:

05. Background/Justification:

06. Estimates of Risk (Medical/Operational):
(i.e. what is the risk of doing and not doing the proposed action?)

07. Validity of Existing Databases:

08. Implementation/Method:

09. Schedule/Milestones:

10. Research Issues and Priority:

11. Comments and Disposition (Action):

Submitted by _____ Date _____ MPB Approval _____ Date _____

Appendix 2

Relevant NASA Management Instructions and Supporting Documents

Medical Requirements Documents: Human Space Flight Programs

NASA Headquarters Policy Documents

Level	Document	Title
I	NPD 1800.2	NASA Occupational Health Program
I	NPC 1152.76	NASA Medical Boards in Support of Space Flight Operations
I	NPD 1810.2	NASA Occupational Medicine Program
I	NMI 1815.1F	Handling of Narcotics and Other Drugs Regulated Under the Controlled Substances Act of 1970
I	CFR 1214.5	Mission Critical Space Systems Personnel Reliability Program
I	NPD 7100.8C	Protection of Human Research Subjects
I	NPD 8900.1E	Medical Operations Responsibilities for Human Space Flight Program
I	NPD 8900.E	Astronaut Medical and Dental Observation, Study, and Care Program
I		Health Council Charter

JSC Management Instruction (JMI)

Level	Document	Title
II	JMI 8610.3B	Space Shuttle In Flight Health Care and Reporting Policy
II	JMI 1800.1A	JSC Occupational Medicine Program
II	1830.1J	Medical Examination of Flight Control Team Members

JSC Level II Documentation

Level	Document	Title
II	JSC 20584	Spacecraft Maximum Allowable Concentrations for Airborne Contaminants
II	JSC 27384	Psychological Services Program: Definition and Implementation Guide (Feb. 1996)
II	JSC 26882	Space Flight Health Requirements Document
II	JSC 27050	Postflight Rehabilitation Plan

Program Specific Documentation

Shuttle

Level	Document	Title
II	20000	Program Requirements Document for Flight
II	20000	Program Requirements Document for Launch and Landing
II	NSTS 07700	Volume VIII Program Definition and Requirements Space Shuttle Operations
II	Appendix I	Orbiter Prelaunch and Landing Contingency/Rescue Operations and Responsibilities
II	Appendix K	Medical Operations Management and Implementation Responsibilities
II	Appendix R	Contingency Landing Response Plan
II	–Attachment 2	Response Personnel
II	–Attachment 6	Emergency Medical Services
II	–Attachment 7	Tables R.1 - R.4
II	–Attachment 9	Onboard Flight Crew Checklists
II	–Attachment 10	Mishap Investigation Team
II	JSC 22538	Health Stabilization Program for the Space Shuttle Program

II	JSC 26546	Medical Operations Flight Support Training and Certification Plan
II	JSC 48031	Medical Checklist Flight Data File Shuttle Program
II	JSC 22276	Medical Console Handbook
II	JSC 24834	Astronaut Medical Evaluation Requirements Document
II	JSC 13956	Medical Operations Requirements Document for Space Shuttle
II	JSC 24734	Medical Operations SOMS Processing Document
II	JSC 16785	Medical Operations Readiness Review Plan
II	JSC 23634	Space Shuttle Medical Debrief
II	JSC 25396	NASA Class III Payload Specialist Astronaut Selection and Annual Certification
II	JSC 18534	Medical Requirements and Operations Plan for STS
II	JSC 22359	Crew Scheduling Constraints
II	JSC 23086	Astronaut Medical Selection Manual
II	JSC 25981	Sleep Shift Support Operations Program
II	JSC 48031	Flight Data File Medical Checklist
II	JSC 48092	Extended Duration Orbiter Medical Checklist
II	JSC 16260	Emergency Medical Kit Pre-Installation Acceptance (PIA) Testing
II	JSC 16259	Medications and Bandage Kit PIA Testing
II	JSC 25268	Medical Extended Duration Orbiter PIA Testing
II	JSC 25220	Airway Medical Accessory Kit PIA Testing
II	JSC 22811	Resuscitator PIA Testing
II	NSTS 11091	Operational Bioinstrumentation System (OBS) Program Requirements Document
II	JSC 22809	Resuscitator Assembly Program Requirements Document
II	JSC 25784	Contamination Cleanup Kit (CCK) Program Requirements Document
II	JSC 48092	Extended Duration Orbiter Checklist
II	JSC 22359	Crew Scheduling Constraints
II	NSTS 12820	Space Shuttle Flight Rules
II	JSC 26548	Medical Operations Flight Support Training and Certification Plan
II	JSC 23634	Space Shuttle Medical Debrief
II	JSC 22276	Space Shuttle Medical Console Handbook
II	JSC 11859	Microbial Contamination Control Plan
II	JSC 14374	Clinical Laboratory Support Plan
II	JSC 18533	Toxicological Support Requirements for the Space Shuttle

International Space Station (ISS)

Level	Document	Title
II	SSP 41000B	System Specification for ISSA Type 1
II	SSP 41162A	Segment Specification for U.S. Onorbit Type A
II	SSP 50153	Project Implementation Agreement for Crew Health Care System
II		*Instructor Certification Guide JSC-XXX
II		*Medical Operations SIM Trainer (MOST) Operations Guide
II		*MOST Scenario Guide
II		*Medical Operations Logistics Procedures
II		*Space Station Console Handbook
II		*Toxicology Procedures Document
II		*Crew Health Care System Reference Guide
II		*Space Station Medical Operations Support Implementation Plans–Russia, other CTV sites
II		*Space Station Handbook Drawings

II		*Mission Controllers Operational Handbook
II	JSC 36186	*Integrated Operations Scenarios (IOS)
II	JSC 36252	*IOS Generic Groundrules Constraints and Assumptions
II	SSP 50261	*ISS Operations Planning Groundrules and Constraints
II		*Multi-Increment Manifest
II		*Assembly Contingency Operations Assessment
II		*Mission Integration Plan
II	SSP 50011-01,02,03	Concept or Operation and Utilization
II	SPIP SSP 50200	*Station Program Implementation Plan NDS I, II, V, VI, VII, VIII, IX, X
II	SSP 41163	Russian Segment Specification
II	SSP 41161	United States Ground Specification
II	SSP 41162	Segment Specifications for the US Onorbit Segment
II	D684-10200-1	Functional Decomposition Document

Documentation and Agreements with Other Agencies/Centers

Level	**Document**	**Title**
	NASA Memo DA8-91-223	Memorandum of Agreement with DOD
II	KBM-P1-1.1	Medical Operations Support Implementation Plan (MOSIP) Kennedy Space Center
II	JSC 16299	MOSIP White Sands Space Harbor
II	JSC 18288	MOSIP Dryden Flight Research Facility
II	JSC 22944	MOSIP Ben Guerir, Morocco
II	JSC 22945	MOSIP Moron, Spain
II	JSC 22946	MOSIP Zaragoza, Spain
II	JSC 22947	MOSIP Banjul, The Gambia

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Appendix 3

Top Ten Health and Medical Issues for Aerospace Medicine

1. **Radiation Protection** – Outside of the protection of Earth's atmosphere and magnetic field, space farers are exposed to a substantially greater amount of radiation, including Galactic Cosmic Radiation (GCR) and small, high-energy particles generated by solar events. NASA has a multidisciplinary radiation working groups at NASA Headquarters and Johnson Space Center, and is working with the National Council on Radiation Protection (NCRP) and international partners on the International Space Station to ensure uniformity of standards, measurements, and the implementation of radiation health maintenance programs.

2. **Hearing Conservation** – Active and passive hearing protection programs have been instituted for space missions including the International Space Station. In addition to Earth-based engineering studies for anticipated decibel levels for equipment on space missions, actual decibel levels are measured aboard spacecraft and noise abatement strategies are employed in hardware design and work, leisure, and sleep schedules, including active noise reduction headgear. NASA is working with its international partners to ensure uniformity of standards.

3. **Countermeasures** – Microgravity promotes cardiovascular deconditioning; muscle and bone loss; fluid loading in the hands, feet, and face; and neurovestibular changes. In order to prevent orthostatic intolerance, dangerous muscle and bone loss, and other potentially deliterous physiological changes from space missions, NASA is actively engaged in developing exercise and pharmacological countermeasures.

4. **Habitability** – Human, animal, and plant life need to be protected from the extreme environments of space or other-than-Earth bodies in spacecraft or habitats. Critical aspects of the habitability of those habitats range from adequate clean and healthy air, food, and water to appropriate work, leisure, and sleeping options. Engineering design and operations currently are tasked to address safety, functionality (human-machine interfaces), and psychological factors, such as the need for privacy or personal space.

5. **Extra-Vehicular Activity** – Substantial time will be spent on space missions outside of the primary spacecraft or habitat, building or performing maintenance functions, performing research, or sample collection. Spacesuits, human maneuvering units, or rovers need to be designed to accommodate human safety and mission success. Issues include gas pressure and mixture, micrometeorite protection, suit materials and locomotion, and emergency survival and rescue.

6. **Medical Care** – In the isolation of space missions, primary medical resources will need to be with space travelers. An appropriate range of medical equipment and expertise (medical training and computerized medical information) will need to be included to address a range of anticipated medical challenges including motion sickness, decompression sickness, radiation exposure, construction work-related injuries, psychological challenges of being removed from ones own culture and family and placed in constant close proximity to one small group, and unanticipated medical challenges.

7. **Diversity** – NASA consistently strives to reflect the diversity of the U.S. population in its work force, on the ground and in space. International cooperation in human space flight brings a new dimension to diversity and the practice of international health.

8. **Stress Reduction** – NASA employees have exciting and challenging jobs on the ground and in space. To maximize employee safety, productivity, and morale, NASA is engaged in workforce studies of stress and ways to minimize any damaging factors in these challenging environment.

9. **Worker's Compensation** – Currently NASA has one of the lowest rates of disability claims and payment in the Federal government.

10. ????