Department of Defense
Para-Rescue Jumpers
NASA Space Life Sciences
October 2009
The requirements to conduct scientific research in support of human space exploration are defined in the:

- NASA Strategic Plan, NASA Policy Directive (NPD) 1001.0
- Exploration Architecture Requirements Document (ESMD-EARD-08-07)
- NASA Human Research Project, Project Plan, HRP-47051 Revision A 2
Mission Objectives

- Provide for crew health and safety
- Understand the effects of the space environment on human performance for long-duration human space exploration
- Provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration
- Enable the definition and improvement of human spaceflight medical, environmental, and human factors standards
- Evaluate the concept of operations for exploration class missions
Mission Science Requirements Definition

Interdisciplinary Approach

Bone Loss | Space Medicine
Cardiovascular Alterations | Nutrition
Environmental Health | Clinical Capabilities
Immunology & Infection | Behavioral Health & Performance
Skeletal Muscle Alterations | Human Factors
Sensory-Motor Adaptation | Radiation
Mission Requirements Definition

Why we do what we do...

Evidence Book → What we know
Knowledge Gaps → What we don’t know
Risks → What we are worried about
Research → How we address the risk

Master plan to close risk for exploration
Mission Science
Example Risks for Exploration Missions

- Risk of Accelerated Osteoporosis
- Risk of Acute or Late Central Nervous System Effects from Radiation Exposure
- Risk of Adverse Health Effects from Lunar Dust Exposure
- Risk of Behavioral and Psychiatric Conditions
- Risk of Bone Fracture
- Risk of Cardiac Rhythm Problems
- Risk of Crew Adverse Health Event due to Altered Immune Response
- Risk of Degenerative Tissue or Other Health Effects from Radiation Exposure
- Risk of Impaired Performance due to Reduced Muscle Mass, Strength, and Endurance
- Risk of Intervertebral Disk Damage
- Risk of Orthostatic Intolerance during Re-Exposure to Gravity
- Risk of Renal Stone Formation

Responsibilities for crew health extend beyond the mission and include the potential for lifetime risk.
# Postflight R+0 Medical Requirements

<table>
<thead>
<tr>
<th>Code</th>
<th>Assessment</th>
<th>Time</th>
<th>Requirement</th>
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<tbody>
<tr>
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<td>Clinical Assessment</td>
<td>1.00</td>
<td>R+0</td>
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<td>MEDB 1.4</td>
<td>Neurological Assessment</td>
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<td>R+0</td>
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<td>R+0/3</td>
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<td>R/0/1</td>
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<td>R/0/1</td>
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<td>MEDB 8.1</td>
<td>Nutritional Assessment</td>
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<td><strong>Total Time</strong></td>
<td><strong>3.59</strong></td>
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</table>

To optimize time commitment, data and samples are shared with mission science. Neurological Assessment, Ophthalmology Examination and Photodocumentation of Skin may be combined with the Clinical Assessment.
Medical -Science Scenarios

- **Scenario 1 (Preferred)** – 4-hr return to land-based BDCF via helicopter
  - Modeled after Shuttle and Soyuz landings
  - Ship-Board Medical Operations Team
    - 2 Flight Surgeons
    - 2 Nurses
    - 0.5 Clinical Lab Med Tech
  - Ship-Board Science Research Team
    - 0.5 Clinical Lab Med Tech
    - 1 Sample Return/Biomedical Test Specialist
    - 2 Science Investigators

- Enables greater capability to perform medical care and mission science to meet Agency/Program objectives
- Requires a helicopter and potential other infrastructure/ship crew
Medical - Science Scenarios

Scenario 2 – 24-hr return to land-based BDCF via ship

Ship-Board Medical Operations Team
  2 Flight Surgeons
  2 Nurses
  1 Clinical Lab Med Tech
  1 ASCR

Ship-Board Science Research Team
  1 Clinical Lab Med Tech
  1 Sample Return/Biomedical Test Specialist
  5 Science Investigators

Science personnel support may vary depending on R+0 science requirements

- Delay in access to flight crew would affect science objectives due to prolonged re-adaptation to 1G
- Limits neurovestibular testing due to ship’s motion
- Limits science operations due to restricted space for equipment and personnel
- Movement of crewmembers may require elevator access (crewmembers may be supine)
- Additional logistical support for ship-board personnel required
### Crew Sample Landing Day Schedule

**Scenario 1 (Preferred) – 4-hr return to land-based BDCF via helicopter**

**Beginning upon arrival to Ship: 00:00**

<table>
<thead>
<tr>
<th>CREW</th>
<th>0:30</th>
<th>1 hr</th>
<th>1:30</th>
<th>2 hrs</th>
<th>2.5 hrs</th>
<th>3 hrs</th>
<th>3.5 hrs</th>
<th>4 hrs</th>
<th>4.5 hrs</th>
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<td>ULTRASOUND</td>
<td>BLOOD DRAW</td>
<td>NOTES 1 &amp; 2</td>
<td>Vitals</td>
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<td>Actwatch</td>
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Crew Sample Landing Day Schedule

Scenario 2 – 24-hr return to land-based BDCF via ship
Requires additional science personnel support

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<td>BLOOD DRAW</td>
<td>Vitals</td>
<td>ACTWATCH</td>
<td>Sleep Log</td>
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<td><strong>Cognitive Performance</strong></td>
<td>Operational Tilt</td>
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Integration of Medical and Science Operations

Some data and/or samples collected during ISS missions are shared between Space Medicine and research investigations (Informed Consent)

R+0 Day

Sleep Logs and Actiwatch
Reaction Self Test
Urinalysis (24/48 hr)
Ultrasound Imaging
Clinical blood analysis
Medication Log
Heart Rate and Blood Pressure
Food Frequency Questionnaire
Health Status Evaluation
Orthostatic tolerance test
Height and Body Weight
Graded Exercise Test Cycle
Ergometry
Isokinetic Test
Metabolic Cost
Functional Task Test
Exercise Logs (duration, intensity, & modality)
DEXA
Rehabilitation record

INTERDISCIPLINARY DATA/SAMPLE SHARING MINIMIZES RISKS, INCONVENIENCES AND TIME TO CREWMEMBERS
Helicopter and Helipad Requirements

- **Helicopter**
  - On 8 Oct 08, the JSC Medical Operation Branch (MOB) consensus was that helicopter support is required to take injured or medically challenged crew member(s) to the nearest hospital facility
  - On 9 Oct 08, the Space Medicine Division Configuration Control Board (SMCCB) concurred with this position

- **Helipad**
  - JSC Medical considers the use of a helipad as the primary means of loading crewmembers onto a helicopter on the ship
    - It is much safer and faster to load ill/injured crewmembers and care providers at a helipad than to do a hoist operation
    - A helipad would keep the helicopter out of the red (danger) area on the Height - Velocity diagram (helicopter diagram in b/u charts)
  - A vote by the L&RWG on whether to have the helipad did not produce a consensus, but the majority favored having the helipad as a requirement
  - During the L&RWG meeting on 10 Aug, it was confirmed that CB supported this position
Medical Support

- All astronauts returning from long-duration (≥30 days) space flight have neurovestibular and cardiovascular disturbances due to re-adaptation to gravity that requires supportive care
  - Based on long-duration space flight experience to date
    - A majority will require treatment including IV fluids and parenteral medications to control their symptoms even at nominal end of mission
    - To support a crew of four individuals, a team of two NASA flight surgeons, two registered nurses, and a clinical laboratory medical technician is required.

- For postflight contingencies requiring crew evacuation:
  - Members of the medical team will accompany each crewmember or groups of crewmembers
  - To the maximum extent possible, injured or ill crewmember will be attended by at least one physician or nurse to support them during the contingency
  - If medical evacuation of a crewmember(s) is required, and space is available, a crew surgeon will accompany the injured or ill crewmember on the medevac
Medical Support

- These team members may not be nominally substituted with other specialists or dual tasked with nonmedical responsibilities

- Nurses could perform blood draws for medical and science experiments as long as there are no conflicts with their primary responsibility for crew medical care

- However, the blood analysis and sample postprocessing would require them to leave the crewmember and would violate protocol.
Open Issues

- Current proposed plan does not address:
  - IP support for medical and science operations
    - International Flight Surgeons assigned to IP crewmembers
    - Multinational crewmembers participating in agency sponsored science
  - VIP attendance including
    - NASA HQ management
    - Flight Director
    - Program Management
Based on both the Medical Operations and Science Research requirements, our recommendation is to support Scenario 1 and the return of the crewmembers to a land – based BDCF within 4 hours of crew return to the ship.

Mission science personnel should be categorized as “Mission Critical”