

**2007 IWG RECOMMENDATION RESPONSES: Results of Behavioral Health and Performance (BHP) Team**

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	The analog environment needs to be feasible to answer the BHP question. This means we need a systematic analysis of the strengths and weaknesses of various analog environments (e.g. NEEMO, Antarctic, etc.) with input from the BHP community.	Gaps - Analogs	PRD- Risk of Performance Error due to sleep loss. Research gap in the current IRP: BHP Gap 1.1.5 - Affects of performance in flight due to sleep loss, circadian, fatigue, work load (collect performance data on NEEMO, Haughton MP, Phoenix ML, Antarctic base, STS/ISS, and Russian Chamber study if possible). Use of analogs not complete. FY09 collect flight data, 2013 req. definition, plus lunar and mars optimization.	This is an ongoing activity within the HRP to analyze utilization of analog environments. BHP is collecting data on NEEMO; will also collect some data from Devon Island/Haughton Mars, and Russian Chamber 105 and 500-day study, and MPL.
02	Psychosocial and neurobehavioral monitoring of autonomous crews in analog environments is essential. Research is needed on optimal ways to monitor with technology the stress, behavioral efficiency and psychosocial functioning of individuals and crews, including ground-based personnel	Gaps - Monitoring	PRD- Risk of Behavioral and Psychiatric Conditions. Research gap in the current IRP: BHP Gap 16 - Measure to assess mood/stress (Tools) BHP Gap 17 - Changes in cognitive decline (Questionnaire)	Currently testing tools in lab and extreme environments (e.g., Mt Everest, NEEMO, Russian Chamber Study, Randomized Clinical Trials)
03	Critical need for pharmacokinetic and pharmacodynamic data in space. A single good study will help PK/PD modeling.	Gaps - Modeling	PRD- Risk of Behavioral and Psychiatric Conditions. Research gap in the current IRP: BHP Gap 19 - Use of medications in flight? BHP Gap 1.2.3 - Crew Quarters Sleep Meds Study (Ground study: involves collaboration with HHC/Pharmacology)	Collaborating with flight surgeon Smith Johnston on this protocol.
04	More information is essential on the role of fatigue (sleep need and circadian phase) on broader aspects of crew functioning in space.	Gaps - Analogs	PRD- Risk of Performance Error due to sleep loss. Research gap in the current IRP: BHP Gap 1.1.1 through 1.3.2 - measures include (Cog Assessment Tool, Fatigue Meter, Cog Performance Studies, Sleep Wake Actigraph, analogs, models, acoustic/photic study, meds)	Testing tools in NEEMO, MPL, Haughton Mars, and Russian 105/500-day study
05	Need to conduct behavioral science (experiments) to find evidenced-based solutions to questions of human neurobehavioral and psychosocial function in space, instead of relying on space flight anecdotes.	Gaps - Analogs	PRD- Risk of Behavioral and Psychiatric Conditions.	James Carter's work (and future work with Russian 105 and 500-day study) is addressing this recommendation to include randomized clinical trials with analogous population.
06	BHP could collaborate with SHFH, Smart Medical, Radiation, Nutrition, Pharmacology, Sensors & Motors, and Bone & Muscle.	Strategic Planning - Collaborations	PRD- Risk of Performance Error due to sleep loss. Research gap in the current IRP: BHP Gap 1.1.5 - Affects of performance in flight due to sleep loss, circadian, fatigue, work load (Requires collaboration with HHC and SHFH in IRP.) BHP Gap 1.2.1 - Minimize circadian problems in space (Requires collaboration with SHFH in IRP.) BHP Gap 1.2.3 - Crew Quarters Sleep Meds Study (Ground study: involves collaboration with HHC/Pharmacology)	Collaborating with flight surgeons Smith Johnson and Jim Locke, BHP Ops, and NSBRI for these gaps; some collaboration with HHC/Pharmacology. No collaboration with SHFH required at this time; results to be shared with SHFH; do not see need to collaborate with other disciplines at this time.
07	Behavioral adherence to countermeasures is an important area of collaboration; BHP has expertise in this area.	Strategic Planning - Collaborations		Requires implementation strategy. To be considered.
08	BHP would like to work with the EVA community to help identify and understand this mental/performance fatigue, and help identify countermeasures for it.	Strategic Planning - Collaborations		Initial discussions held; further work required.

## 2007 IWG RECOMMENDATION RESPONSES: Results of Bone Team

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Risk assessment will require a combination of QCT and modeling techniques (FEM and stochastic) to improve estimates of fracture risk during and after the mission, especially to define long term health risk.	Gaps - Modeling	<p>PRD - Risk of Bone Fracture.</p> <p>Research gaps in the current IRP: Gaps: B1: Is bone strength completely recovered with recover of BMD?; B2: What technologies are available for in-flight diagnosis?; B10: What is the time course of bone demineralization during flights greater than 90 days on ISS and during Lunar Outpost missions?</p> <p>Activities: Response to current NRA (Bone recovery, Monitor Bone Quality Changes, Bone Turnover Analysis); Lunar Analog/BR (FAP)</p>	Ground QCT and modeling ideal, but constraints exists with radiation doses (FAP). Would like to implement QCT to implement bone quality indices; it would be easy to combine with modeling for 3D imaging. Currently, there is a NASA funded external PI who has applied modeling to QCT data. Want to be able to apply QCT it during the recovery period in a ground-based study. QCT should become standard measure for bone quality changes; this is a non-invasive procedure.

## 2007 IWG RECOMMENDATION RESPONSES: Results of Immunology and Microbiology Team

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Use ground-based analogs.	Gaps - Analogs	Research tasks in the current IRP: NEEMO Rapid Operational Investigation (ROI): Immune function changes during a spaceflight-analog 10-day undersea mission; 3D Tissue Analogues For The Study Of Varicella-Zoster Virulence And Infectivity	The Immunology discipline has conducted studies on recent NEEMO missions. In addition, the ground analog of choice is the Concordia Antarctic Station. There is currently a proposal entitled "Consequences of long-term- <i>C</i> onfinement and <i>H</i> ypobaric hypo xia on <i>I</i> mmunity in the Antarctic <i>C</i> oncordia <i>E</i> nvironment ( <b>CHOICE</b> - Study)" that is pending funding, stability and sample preservation studies are included with this.
02	Direct research toward establishing quantifiable flight requirements for immune status that mitigate risks to mission success, crew performance, and acute and chronic health problems.	Gaps - Flight Resources	Research tasks in the current IRP: Flight-Induced Changes in Immune Defenses: 'Immune Function,' DSO 498/SDBI 1498, Incidence of Latent Virus Shedding During Space Flight: 'Latent Virus,' DSO 493/SDBI 1493; Space Flight-Induced Reactivation of Latent Epstein-Barr Virus: 'Epstein-Barr,' on Shuttle as DSO 493/SDBI 1493 and ISS as E129; Validation of Procedures for Monitoring Crewmember Immune Function: 'Integrated Immune SMO,' SMO 015/SDBI 1900	DSOs 498 and 493 are completed and will be replaced by the Immune SMO 015. Agreement in place with IBMP to participate in BION.
03	The effects of other countermeasures on immune function must be determined.	Gaps - Future needs		This is future work.
04	Identify changes in potential countermeasures to microbial characteristics specific to space flight which could increase risk to mission success, crew performance and health.	Gaps - Flight Resources	Additional SWAB experiments to be conducted in post-Increment 19 efforts..	During Expeditions 13, 14, &15, Surface, Water and Air Biocharacterization (SWAB) - A Comprehensive Characterization of Microorganisms and Allergens in Spacecraft Environment was performed. Present countermeasures include spacecraft design, preflight monitoring, in-flight monitoring, and housekeeping.
05	Determine the effect of space flight on wound healing.	Gaps - Future needs		There is a need this; the Immune team is interested in this topic.
06	Immunology & Microbiology could collaborate with Radiation, Bone, Nutrition, Muscle, Neurobehavioral and Psychosocial Factors.	Strategic Planning - Collaborations	Research tasks in the current IRP: Rad Cancer-15, Rad CNS-10, Rad Degen-10, Rad Acute-5, Rad Acute-7	Currently, research IRP gaps exist that would promote integration and collaboration across Projects and Elements.

## 2007 IWG RECOMMENDATION RESPONSES: Results of Muscle Team

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Identify a resistive exercise device which meets the vehicle constraints of mass, volume, and power.	Gaps - Flight Resources		Novel exercise concepts solicited for in current joint NSBRI/NASA NRA and in latest SBIR. In addition, GRC has FY08 funding for advanced exercise concepts.
02	Exercise intensity is the primary mechanism for maintaining muscle strength and mass. Education of crew surgeons and engineers on why this is necessary.	Gaps - Data Analysis	PRD Risk: Impaired Performance Due to Reduced Muscle Mass, Strength, Endurance Research gaps in the current IRP: Muscle Gaps M10 Activities: Rx Optimization	ECP is addressing optimized exercise prescriptions, including extensive literature reviews and review of on-orbit data where high intensity-type protocols were utilized. IRP includes a plan for evaluation and validation of improved exercise prescriptions.
03	Method to measure and monitor muscle health and performance in the course of the mission. Develop tests which will be predictive of mission tasks.	Gaps - Flight Resources	PRD Risk: Impaired Performance Due to Reduced Muscle Mass, Strength, Endurance Research gaps in the current IRP: Muscle Gaps M6: Critical Mission Task Assessment	ECP developing a protocol to use ARED for ISS on-orbit muscle function testing. In addition, joint NSBRI/NASA NRA topic was improved muscle monitoring hardware/tools. ECP had initiated task assessments of anticipated mission tasks to identify physiologic requirements to complete these tasks, appropriately size exercise countermeasures, and predict performance.
04	Exercise prescription should be optimized (intensity, frequency, duration, and modality) to make as efficient as possible.	Gaps - Data Analysis	PRD Risk: Impaired Performance Due to Reduced Muscle Mass, Strength, Endurance Research gaps in the current IRP: Muscle Gap: M1 (BR Rx Optimization studies, DAP - 2008)	ECP is addressing optimized exercise prescriptions, including extensive literature reviews and review of on-orbit data where high intensity-type protocols were utilized. IRP includes a plan for evaluation and validation of improved exercise prescriptions.
05	Use bed rest as a model to work through these issues, validate on ISS, and take forward to moon and Mars.	Gaps - Analogs; Future needs	PRD Risk: Impaired Performance Due to Reduced Muscle Mass, Strength, Endurance Research gaps in the current IRP: Muscle Gaps: M7, M8, M9, M10 (BR Rx Optimization)	ECP is addressing optimized exercise prescriptions, including extensive literature reviews and review of on-orbit data where high intensity-type protocols were utilized. IRP includes a plan for evaluation and validation of improved exercise prescriptions.
06	Collaboration with other groups necessary (bone, nutrition, cardiovascular, etc.) to test that countermeasure for muscle as complimentary, or at least not inhibiting, to countermeasures for other systems. Goal to define an integrated countermeasure and reduce overall countermeasure time and overhead factors.	Strategic Planning - Integration		Need to establish countermeasures first; then integration will be planned.
07	Collaboration with International Partners and academic institutions is necessary in order to leverage their knowledge base, hardware development, and increase number of subjects for testing countermeasures.	Strategic Planning - Collaborations		ECP trying to establish closer ties with NSBRI colleagues, using the Muscle Discipline team as a forum for new activities (e.g., Functional Task Test).
08	Should continue to consider nutritional and pharmacological interventions	Gaps - Future needs		Countermeasure optimization studies are captured in IRP, however not well integrated amongst types of Countermeasures (e.g., exercise, nutrition, etc.). Forward work is needed.
09	Need more complete understanding of musculoskeletal injury potentials, outcomes, and treatment which may affect mission task performance and what role countermeasures may have in mitigating these risks.	Gaps - Future needs		Should be considered in analysis of medical risks and evidence base (e.g., Integrated Medical Model).

**2007 IWG RECOMMENDATION RESPONSES: Results of Neurovestibular / Sensorimotor Team**

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Spatial disorientation: A manually controlled landing on Mars following a 6-month transit will pose a significant sensorimotor challenge. The sensorimotor team should continue to "data mine" to monitor crew performance for evidence of spatial disorientation effects, particularly as it relates to future programs.	Gaps - Data analysis	Research gaps in the current IRP: SM6: Need to perform a seated Manual/Visual performance assessment after long-duration spaceflight. Head-eye Coordination during Simulated Orbiter Landings; Required Delivery Milestone: SM11: Need to provide alternate sources for spatial orientation.	Writing white paper on spatial disorientation (evidence base), forward work and gaps. IRP does not yet address Mars.
02	We agree that further interpretation of the STS/STA comparison data is required.	Gaps - Data analysis		Data mining proposal submitted as directed study; currently awaiting approval.
03	Space Motion Sickness -- prediction, prevention, and treatment of both acute and chronic syndromes. More could also be done than we are doing now to teach crewmembers what is already known about the causes of space sickness, and effective pharmacologic and non-pharmacologic means of controlling it.	Strategic Planning - Implementation	Research gaps in the current IRP: PH7: What are the effects of spaceflight on Pharmacokinetics/Pharmacodynamics? Bioavailability and Performance effects of Promethazine (PMZ) during spaceflight	These tasks are currently being worked by Space Medicine. Dr. Putcha has NSBRI-funded research that is in it's last year of funding; an extension will be requested.
04	We think this is important that the current NASA short radius AG - bed rest studies be completed and data analyzed, and that bone, muscle, cardiovascular and neurovestibular function data from long duration ISS astronauts in 0-G and Lunar EVA astronauts in 1/6 g be carefully assessed.	Gaps - Analogs	Head-eye Coordination during Simulated Orbiter Landings	1) AG Pilot study completed; data analyzed and publication is in work. 2) Assessments of physiological data from ISS crew members are continuing. Planning in progress for lunar studies.
05	Understanding individual differences in susceptibility to bone loss, and possible genotypic or phenotypic markers seems critical. NASA and NSBRI have considerable facilities and expertise in the bone, muscle and AG research domains. Since these will be required again within a decade, NASA should not entirely abdicate leadership in AG research to partner countries, as seems to be happening now.	Strategic Planning - Collaborations	Research gaps in the current IRP: SM7: Need for an integrated post-flight functional task performance test to be used on returning ISS crew members. Develop and validate operational tests to define the linkage between functional capabilities and physiological changes. This task should include planetary EVA-like activities	International Partners are continuing AG research. U.S. has potential to fund research in IP facilities.
06	We also are fully supportive of an interdisciplinary research plan that will investigate the effects of long-duration space flight, using ISS crewmembers, on spatial orientation and manual control skills necessary for landing a vehicle on the surface of Mars.	Strategic Planning - Integration	STS/ISS Functional Task Test	Writing white paper on spacial orientation (evidence base), forward work and gaps. Research work in this area is contingent upon current data mining efforts.
07	We would like to gain additional operational data and insight regarding Shuttle landings that occurred outside the operational limits to determine the multi-factorial causes that lead to the landing outcomes. Based on the lessons learned from this analysis, we hope to work with the Constellation program going forward to make sure that the evidence for sensorimotor changes in crew performance as a result of space flight is thoroughly assessed.	Gaps - Data analysis; Interface with Constellation	RISK OF IMPAIRED ABILITY TO MAINTAIN CONTROL OF VEHICLES AND OTHER COMPLEX SYSTEMS Risk (From PRD); Risk of Impaired Ability to Maintain Control of Vehicles and Other Complex Systems Research gaps in the current IRP: SM1: Relationship between the mode of in-flight exercise and post-flight sensorimotor performance? Sensorimotor Performance Data Mining SM6: Need to perform a seated Manual/Visual performance assessment after long-duration spaceflight. Required Delivery Milestone:	1.) Intramural proposal on data mining in progress. 2.) Working to engage with Constellation. Additional focus on Constellation interface and technical meetings is needed.

08	For long duration spaceflight (e.g., ISS increments or Mars missions) the team has been advocating a combination of EVA strength and balance training.	Gaps - Future needs		Planning for work in this area continues.
09	Most astronauts adapt within a few days, but -- as with seasickness in Navy operations -- some do not. Understanding (and predicting) the reasons for this outlier behavior is important.	Gaps - Analogs		Solicitation being considered for future NRA call. Currently trying to understand contributing factors.
10	A small investment in new pharmacologic and non-pharmacologic approaches to mitigate SMS may pay off significantly with improved overall performance and increased flexibility of scheduling particularly during the first three days of flight.	Strategic Planning - Implementation		These tasks are currently being worked by Space Medicine.
11	We noted that although the JSC and NSBRI investigators in our area have been meeting at least twice annually in recent years but the NASA NRA program investigators have largely not been invited to participate in this process. They should be encouraged to participate in our regular meetings and we suggest that these investigators also be invited to attend the 2008 HRP Workshop next year.	IWG Planning		All funded grantees have been included in invitation to 2008 IWG.
12	Combine the meeting or sequence it with the Habitability and Human Factors investigators' meeting, as was done very productively several years ago.	IWG Planning		Good recommendation. Coordination of meeting dates is dependent on numerous schedules.
13	Invite more representatives from EPSP and foster breakout sessions so they can contribute on a face-to-face informal basis with at least the sensorimotor, muscle, radiation, and behavior and performance team discussions.	IWG Planning		All funded grantees have been included in invitation to IWG. This coordination can be accomplished through the DIPT as well.
14	The CEV and lunar mission briefings this year were extremely valuable. Include and expand these next year.	IWG Planning		This recommendation is reflected in the 2008 IWG schedule.
15	Discipline Sessions: The 2-minute talk overviews were useful, however, should be limited to 1 slide rather than 2. Too many posters (16) for a thorough formal discussion. Overview talks by team leads on risks and research progress in each discipline are useful, particularly to investigators, flight surgeons and managers who are crossing beyond familiar disciplinary lines.	IWG Planning		This recommendation is reflected in the 2008 IWG schedule.
16	Breakout sessions need more time for strategic discussion.	IWG Planning		This recommendation is reflected in the 2008 IWG schedule.

**2007 IWG RECOMMENDATION RESPONSES: Results of Nutrition Team**

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Recommend joint prioritization between NASA and NSBRI and input from extramural discipline experts	Strategic Planning - Prioritization	N2: What is the optimal dose of vitamin D supplementation? N3: How do nutritional status/nutrition requirements change during spaceflight? N10: What are the risks of mineral/metal release from bone? N7: What are the K+, Mg+ and P+ changes in relation to cardiovascular issues and bone loss? Vitamin D Status in an Antarctic Ground Analog of Space Flight: Nutrition Status Assessment – SMO O16E: Nutrition SMO.	Coordination of NASA, NSBRI and extramural discipline experts is achieved through the recently constructed Nutrition DIPT.
02	Make prioritization transparent and use for solicitations and reviews of proposals.	Strategic Planning - Prioritization		Prioritization is accomplished for each NRA call and is inherent in the Program's approach in the IRP
03	Better access to population-based research data and better connection between the data and setting the research priorities.	Gaps - Data analysis	Research gaps in the current IRP: N7: What are the K+, Mg+, and P+ changes in relation to cardiovascular issues and bone loss? Activity: Nutrition Status Assessment – SMO O16E: Nutrition SMO	The recommendation has been addressed in the IRP.
04	Transparent and timely access to ground-based analogs such as the bed rest project, NEEMO, Devon Island, etc.	Gaps - Analogs	Research gaps in the current IRP: N2: What is the optimal dose of vitamin D supplementation? Vitamin D Status in an Antarctic Ground Analog of Space Flight, Nutrition Status Assessment – SMO O16E: Nutrition SMO, Required Platforms: N3: How do nutritional status/nutrition requirements change during spaceflight? Nutrition Status Assessment – SMO O16E: Nutrition SMO, Required Platforms: N15: Can nutrition/nutrients mitigate O2/radiation risks? NEEMO Rapid Operational Investigation (ROI) study: Characterization of Oxidative Damage during a 12-day Saturation Dive, Required Platforms: N10: What are the risks of mineral/metal release from bone? Activity: Nutrition Status Assessment – SMO O16E	NASA Nutrition personnel participated in last 2 NEEMO missions; need NSBRI Nutrition researchers to participate. Indeed, overall, some sort of defined program path or mechanism to participants in analog studies is needed. Discipline would bring plan forward. At least 2 proposals to NRA to do NEEMO studies are in preparation now.
05	An overall plan for implementing research post assembly completion of ISS. Communication of the limitations (upmass, astronaut time, etc.)	Strategic Planning - Implementation		The IRP addresses this recommendation. This is also a post-Increment 19 flight queue study on-going to address this recommendation. There will be some agency-level decision making regarding limitations that HRP may not be privy to for some time.
06	It is critical to maintain the nutritional potency of the foods, particularly for long duration space flight.	Gaps - Flight resources	9.0 RISK FACTOR OF INADEQUATE NUTRITION Risk Factor of Inadequate Nutrition Research gaps in the current IRP: N1: Are nutrients in food are stable during space flight? Activity: Stability of Pharmacotherapeutic and Nutritional Compounds: Stability SMO (Flight)	Stability SMO is the first step in addressing this recommendation.

07	More non-invasive, unobtrusive methods for monitoring are needed to assess nutritional status, countermeasure effectiveness of nutrition interventions, and effect of nutritional status on other physiological systems.	Gaps - Future needs		While studies are underway to evaluate nutritional status and impact/inter-relationship of countermeasures, non-invasive/unobtrusive techniques are not currently in development.
08	In addition to organ systems, need to address on the cellular level, e.g. oxidative stress.	Gaps - Future needs	Research gaps in the current IRP: EPSP9: What suit-human biomechanical interaction aspects of the EVA suit design affect protection of crew health, and what design changes or countermeasures can be implemented to protect crew health? Identify mechanisms of suit-induced injury	This is a part of the current joint NASA NSBRI NRA solicitation.
09	Resolve the issue of depressed energy intake in space and communicate the importance of maintaining an anabolic metabolism in space.	Strategic Planning - Implementation		Working to fix with education of all involved, including crew training. An example of this concern: food allocations for Constellation missions are not clearly defined.
10	Need direct communication with flight docs and crews as to effect of a catabolic state on functional endpoints.	Strategic Planning - Implementation		Investigators and flight surgeons understand the affects of catabolic end states. Need to establish a better path for communicating occurrences and results.
11	Clear data are needed on which nutrient needs are the same on earth as in space and which ones aren't, and the magnitude of the difference. Also, how can this be dealt with in foods/supplements?	Gaps - Future needs		Need better understanding of nutritional requirements for ISS and exploration missions.
12	Need to determine most effective way to deliver the nutrients and energy required during EVAs.	Gaps - Future needs	Research gaps in the current IRP: EPSP5: What are the energy/hydration requirements and associated waste management requirements of EVA, and what kind of integrated delivery/management systems can be supported in an EVA suit? Determine energy, nutrient, hydration and waste management requirements	The recommendation has been addressed in the IRP.

## 2007 IWG RECOMMENDATION RESPONSES: Results of Radiation Health Team

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Use ground-based analogs of space flight.	Gaps - Analogs	Research gaps in the current IRP: Rad Cancer-2, Rad Cancer-5, Rad Cancer-11, Rad Cancer-14, Rad Cancer-15, Rad Cancer-17, Rad CNS-5, Rad CNS-5, Rad CNS-6, Rad CNS-7, Rad CNS-8, Rad CNS-10, Rad Degen-2, Rad Degen 3, Rad Degen-6, Rad Degen-7, Rad Degen-10, Rad Acute-5, Rad Acute-7, Rad Acute-10	The IRP contains plans for the continued reliance on ground-based analogs.
02	Establish an emergency action plan with a step-by-step approach for astronauts who are unprotected on the surface of the moon during a solar particle event (SPE). Physical and biomedical countermeasures should be part of this action plan.	Operational Issues		Will be a Medical Operations contingency activity.
03	Establish surrogate endpoint biomarkers (SEBs) for the radiation-induced adverse biological effects of concern during an SPE, and determine the effects of countermeasures on these SEBs.	Gaps - Analogs	Research gaps in the current IRP: Rad Cancer-2, Rad Cancer-4, Rad Cancer-7, Rad Cancer-10, Rad Cancer-1, Rad Cancer-14, Rad CNS-4, Rad CNS-5, Rad CNS-5, Rad CNS-6, Rad Degen-2, Rad Degen-3, Rad Degen-8, Rad Degen-9, Rad Acute-3, Rad Acute-8	NSBRI will solicit research in acute effects in near future. In October 2007, there was a 'NASA Models of CNS Space Radiation Risk and Flight Interaction Workshop', which addressed Behavioral Health & Performance issues.
04	As radiation itself can introduce uncertainty in the physical measurement of dose, human biodosimetry should be established for doses of space radiation in addition to physical measurements.	Gaps - Monitoring	Research gaps in the current IRP: Rad Cancer-20, Rad Acute-9	The recommendation has been addressed in the IRP.
05	Areas of collaborations	Strategic Planning - Integration and Collaborations	Research tasks in the current IRP: Rad Cancer-15, Rad CNS 10, Rad Degen-10, Rad Acute-5, Rad Acute-7	Currently, research gaps exist that would promote integration and collaboration across Projects and Elements. Investigating possible impacts of nutritional deficiencies on long duration missions on Radiation risk assessment; also see above for workshop with BHP.

## 2007 IWG RECOMMENDATION RESPONSES: Results of SHFE Habitability Team

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Need lunar & Mars robotic precursor missions to characterize and assess toxicity of lunar dust (i.e., in situ analysis of activated dust.)	Gaps - Future Needs		This goes into recommendations for Constellation research. AEH personnel are discussing this with the lunar robotic precursor mission team.
02	We must be aware of and adapt to the Constellation schedule as a driver to prioritize our gaps.	Constellation Interface		The IRP shows the relation of SHFE work to Constellation schedule.
03	Work with Exploration Medical Capabilities and NSBRI technology teams.	Strategic Planning - Collaborations		SHFE is collaborating with ExMC and planning collaborations with NSBRI.
04	Need HRP assistance in connecting with other NASA programs such as precursor missions, and to connect with other government agencies such as DoD, Homeland Security, DoT, etc.	Strategic Planning - Collaborations		These topics are addressed by tasks in the SHFE IRP. Actively pursuing collaborations via directed studies.
05	HRP should explicitly acknowledge that 'human' means more than just crew (e.g., mission success requires MOD, manufacturing, maintenance, etc.).	Strategic Planning - Implementation		The recommendation has been addressed in the IRP.
06	Research and Technology in the following areas is critical: 1) Safety, Productivity, Comfort, 2) Cross Cutting: Communications/coordination, and 3) Mixed agents - robot & human; Control authority - immediate and remote operations.	Gaps - Future Needs		The recommendation has been addressed in the IRP.
07	Need to further develop technologies to provide safe, nutritious food and storage (e.g., ease of preparation, minimize crew time). The methods of testing and validation are lacking.	Gaps - Future Needs; Validation	PRD - Risk of Inadequate Food System Research gaps in the current IRP: AFT 1-6 Activities: Nutrient Dense Food Development; Effect of Retort Process on Nutritional Content; Effect of freeze-drying on nutritional content; Effect of space radiation on nutrition; Effect of time and temperature on nutrition; Advanced Packaging Material Development; Partial Gravity and Atmospheric Effects on Food processing and preparation; Food processing vs. packaged food system trade study; Develop processing and preparation equipment procedures;	The recommendation has been addressed in the IRP.
08	Training for missions - JIT/continuing education; continued professional development. New things pushed to crew.	Gaps - Training	PRD - Risk of Error Due to Inadequate Information Research gaps in the current IRP: SHFE 2 - measure proficiency in training. Activities: Medical Proficiency Training, Spaceflight Resource Management Training	The recommendation has been addressed in the IRP.
09	Reduce threat due to poor interfaces resulting in safety hazards - develop clear testing process and validation methods.	Gaps - Validation	PRD - Risk of Reduced Safety and Efficiency Due to Poor Human Factors Design Research gaps in the current IRP: SHFE 5 - Develop Tools and Models for Constellation design validation	BHP is lead for this topic. We are collaborating the Element.

10	Availability and establishment of process, from a QA standpoint, of how to address all human factors concerns.	Gaps - Future Needs	PRD - Risk of Reduced Safety and Efficiency Due to Poor Human Factors Design Research gaps in the current IRP: SHFE 5 - Develop Tools and Models for Constellation design validation	The recommendation has been addressed in the IRP.
11	Need metrics for psychometric and sensorimotor, cognitive performance. Need performance tripwires.	Gaps - Future Needs	PRD- Risk of Performance Error due to sleep loss. Research gaps in the current IRP: BHP Gap 1.1.5 - Affects of performance in flight due to sleep loss, circadian, fatigue, work load (Requires collaboration with HHC and SHFH in IRP.) BHP Gap 1.2.1 - Minimize circadian problems in space (Requires collaboration with SHFH in IRP.)	The recommendation has been addressed in the IRP.
12	Need smaller monitors that cover all contaminants; possible real-time feedback to ECLSS; Objective data for net habitable volume requirements, and for volumes for specific tasks.	Gaps - Monitoring		The first two items - monitors and feedback to ECLSS - are the responsibility of Exploration Technology Development Program (ETDP). The second two - net habitable volume - are addressed in the IRP.

**2007 IWG RECOMMENDATION RESPONSES: Results of Smart Medical Systems, Technology Development and Exploration Medical Capability Teams**

#	Recommendation	Category	Examples of how is the recommendation addressed in the IRP?	Annual progress
01	Budget/resource constraints are well known, but it would be helpful to have NASA provide a list of what the constraints are (e.g., when is FDA approval required, volume/mass limitations, data requirements, timelines/schedules, and schedule drivers.)	Program-level Issues		This is best accomplished by working with the appropriate Element or Project.
02	Broad stakeholder agreements between NASA and NSBRI which include long term commitments and ongoing dialog would help to reduce some of the uncertainty for NSBRI projects.	Program-level Issues		NASA has renewed the cooperative agreement with NSBRI for another 5 years. The NASA/NSBRI Steering Committee meets monthly to plan and review cooperative work.
03	Processes should be identified and defined for external investigators and internal NASA elements so responsibilities are clear.	Strategic Planning - Implementation		Processes are currently being integrated into the Program Implementation Plan. Roles and responsibilities are being clarified in Revision C of the HRP Science Management Plan as well as the update to the HRP Program Plan.
04	Establishment of consistent feedback loops between technology providers and technology users/customers is needed.	Strategic Planning - Implementation		Section 9.0 of the HRP Science Management Plan contains the process for technology development.
05	Developers with less experience in the NASA system may require additional guidance and funding to successfully integrate their technology with NASA.	Strategic Planning - Implementation		This is best accomplished by working with the appropriate Element or Project.
06	The following are considered critical to humans on the moon and on exploration missions to Mars: IV water generation, body temp, exercise and integrated monitoring, hearing monitoring, advanced field dentistry, virtual mentor- e.g. Guideview, reusable blood, urine, saliva analyzer, long shelf-life anesthesia, long shelf-life meds and status monitoring, airway disease treatment, improved dust countermeasures, blood count, improved radiation monitoring, bone marrow stem cell usage for SPE damage, radiation protection agents, bone loss monitoring and treatment, ultrasound, and pharmaceutical tracking.	Gaps - Future needs		The following are currently in the IRP: IV water generation; body temp; virtual mentor (e.g., Guideview); reusable blood, urine, saliva analyzer; long shelf-life anesthesia; blood count; bone loss monitoring; and ultrasound. The following still need to be addressed: exercise and integrated monitoring; hearing monitoring; advanced field dentistry; long shelf-life meds and status monitoring; airway disease treatment; improved dust countermeasures (SHFH); improved radiation monitoring; bone marrow stem cell usage for SPE damage (RAD); radiation protection agents (RAD); treatment; and pharmaceutical tracking.