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**2014 Occupant Protection Risk Standing Review Panel  
Status Review**

**Statement of Task for:**  
*Risk of Injury from Dynamic Loads*

**Comments to the Human Research Program, Chief Scientist**

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2014 Occupant Protection (OP) Risk Standing Review Panel (SRP) Status Review  
WebEx/teleconference Participants:

**SRP Members:**

Frank Pintar, Ph.D. (Chair) – Medical College of Wisconsin  
Paul Ivancic, Ph.D. – Yale University School of Medicine  
Michael Kleinberger, Ph.D. – Johns Hopkins University

**NASA Johnson Space Center (JSC):**

Pam Baskin, B.A.  
Ronita Cromwell, Ph.D.  
Charlene Gilbert  
Nate Newby, Sc.M.  
Peter Norsk, M.D., dr. med.  
Michele Perchonok, Ph.D.  
Mark Shelhamer, Sc.D.  
LaRona Smith  
Jeffrey Somers  
Susan Steinberg, Ph.D.  
Jessica Wells

**NASA Headquarters (HQ):**

Bruce Hather, Ph.D.

**NASA Research and Education Support Services (NRESS):**

Tiffin Ross-Shepard

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On December 9, 2014, the OP Risk SRP, participants from the JSC, HQ, and NRESS participated in a WebEx/teleconference. The purpose of the call (as stated in the Statement of Task) was to allow the SRP members to:

1. Receive an update by the Human Research Program (HRP) Chief Scientist or Deputy Chief Scientist on the status of NASA's current and future exploration plans and the impact these will have on the HRP.
2. Receive an update on any changes within the HRP since the 2013 SRP meeting.
3. Receive an update by the Element or Project Scientist(s) on progress since the 2013 SRP meeting.
4. Participate in a discussion with the HRP Chief Scientist, Deputy Chief Scientist, and the Element regarding possible topics to be addressed at the next SRP meeting.

Based on the presentations and the discussion during the WebEx/teleconference, the SRP would like to relay the following information to Dr. Shelhamer, the HRP Chief Scientist.

1. The presentations from Dr. Shelhamer and Dr. Norsk provided an excellent overview and perspective of NASA's mission plans, from current near-Earth missions to the International Space Station (ISS) to long-range planetary missions to Mars. These presentations were well organized and clearly presented.
2. The SRP thinks the Human Research Roadmap is nicely organized. The Risk Rating for each risk is a bit confusing as certain mission types (Lunar, Deep Space Journey) are labeled as "Not Applicable" when the meaning is perhaps "not defined".
3. During Dr. Shelhamer's presentation it was noted that risks associated with Soyuz flights will end sometime in FY16 or FY17. Further explanation revealed that Boeing and Space-X were designated as transport vehicles to and from the ISS. The SRP thinks that if the current OP standards being worked on are specifically directed at these two types of vehicles as a first priority then some current configuration information would be valuable.
4. The presentation by Jeff Somers was also well presented and contained a great deal of programmatic and technical information. The OP portfolio has made great progress over the past year, and has been responsive to the SRP's previous comments and suggestions. The schedule of planned activities seems like a reasonable approach to address the various knowledge gaps.
5. The SRP was pleased to see that the OP research plan is moving forward. The research plan, as laid out addressing different gaps in knowledge, is well thought out and should generate abundant new information related to addressing OP standards.
6. The commercial crew program seems to offer some additional challenges since NASA will not have full control of the vehicle design process. It will be critical for NASA to establish a set of performance specifications that will encompass a wider range of potential loading profiles and seating positions. Jeff Somers was not able to provide the

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SRP with details about the planned commercial vehicle designs but this may require that planned testing and analyses be expanded to include a broader set of acceleration pulses, seating positions, and loading directions.

7. Related to other Human Health Countermeasures (HHC) portfolios, it was noted that bone loss due to weightlessness may be different than bone loss due to osteoporosis. The SRP thinks this would be an important distinction to determine as research models from osteoporosis may be less predictive and less related to bone strength. Bone strength is related to occupant injury thresholds and this type of reduction in bone strength due to spaceflight deconditioning will be important to define.
8. The SRP found the data on injuries from Soyuz landings to be enlightening. This type of data is critical and the more this information can be related to vehicle events and, ideally, vehicle measures, the better. This type of data is informative for defining OP standards and perhaps limiting the scope of the project.
9. With respect to injuries due to Soyuz landings (nine of 24 experienced an injury), the SRP thinks all efforts should be made to obtain the seat acceleration data for these cases. This will enable analyses of the peak accelerations, durations, and directions that caused injury in the actual landings. These data may be helpful in the future to guide future standards.
10. The current requirements and anthropomorphic test device (ATD) metrics were discussed during the WebEx/teleconference. The SRP suggested examining relatively new criteria such as Brain Injury Criterion (BRIC) for concussion and the Skull Fracture Correlate (SFC) for skull fracture. Research articles were provided to the OP portfolio lead.
11. As discussed during the WebEx/teleconference, the question about the effects of deconditioning on the injury threshold of the spine continues to be an important factor for consideration. The OP portfolio has laid out several tasks to address this gap, and the SRP looks forward to seeing the results during future reviews as those tasks are completed. The SRP would also encourage the OP portfolio to continue with their efforts to analyze as much existing data as possible, especially any data involving live human subjects.
12. The SRP was a bit disappointed that no dummies or acceleration measures were made on the Exploration Flight Test-1 with Orion. The SRP understands that it is often very difficult to add dummies to such a test, but even attaching accelerometers to vehicle components would have been valuable recordings. The SRP urges the OP portfolio to get such information whenever possible.
13. The suit characterization study data presented during the WebEx/teleconference showed a dramatic increase in head flexion relative to the helmet due to a modified restraint system. The SRP thinks inclusion of accelerometers on both the head and helmet would enable computation of linear and rotational head accelerations relative to the helmet to

evaluate injury potential. This may lead to a revised injury prevention system such as padding within the helmet that activates at a predetermined acceleration threshold.

14. The SRP was told that 5th percentile female dummies and 95th percentile male dummies are being tested to provide dynamic responses for the extreme cases. Subject to resources, the SRP recommends also testing the 50th percentile. This would provide response data that would more closely match the majority of actual astronauts. It would also enable more accurate extrapolation of responses between the 5th and 95th percentiles.
15. The SRP would like the OP portfolio to provide them with any final report or recommendations from the recently held Acceptable Risk Summit. In addition, the SRP would like to get a copy of the paper summarizing the findings from the expert panel on injury criteria.