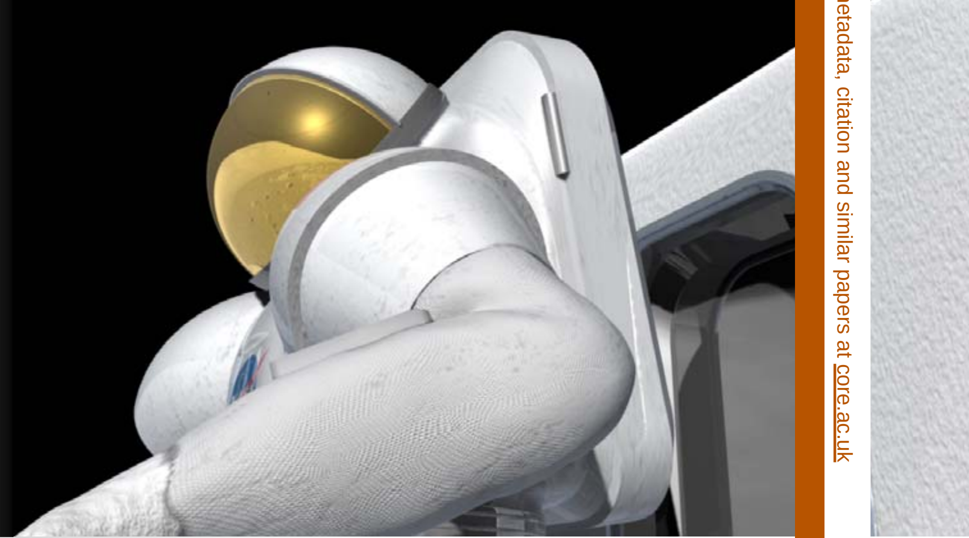


Health and Safety Benefits of Small Pressurized Suitport Rovers as EVA Surface Support Vehicles

Michael L. Gernhardt, Ph.D.[1]

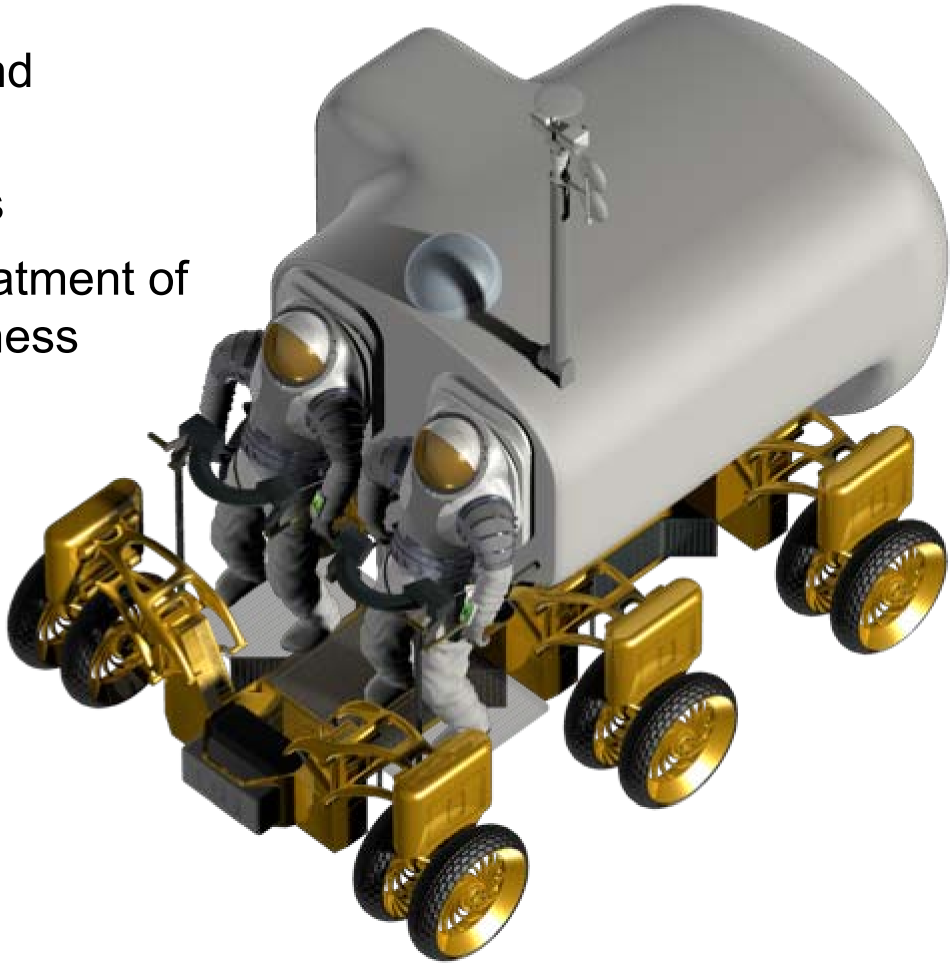
Andrew F. J. Abercromby, Ph.D.[2]

[1] NASA Johnson Space Center, Houst TX

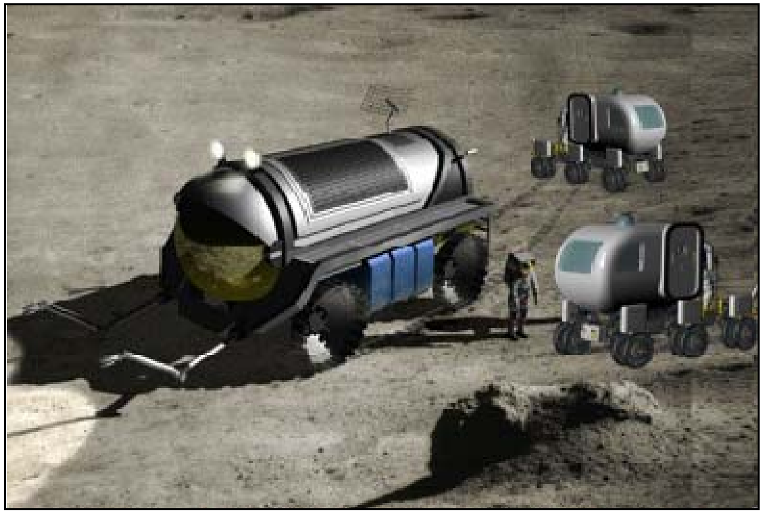
[2] Wyle Laboratories, Inc., Houston, TX

Overview

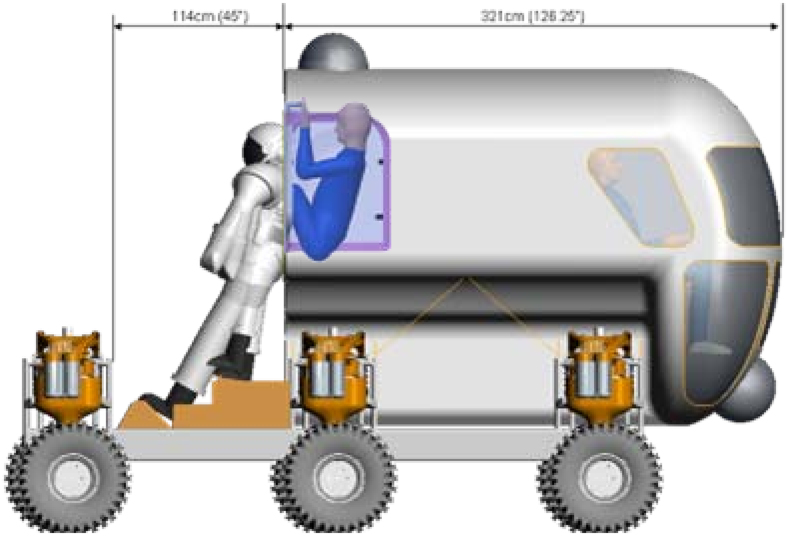
- Current Small Pressurized Rover Design
- Radiation Protection
- Suit-Induced Trauma
- Improved Nutrition, Hydration and Waste Management Options
- Reduced Decompression Stress
- Pressurized Safe Haven for Treatment of Injuries or Decompression Sickness
- Exercise Countermeasures
- Conclusions

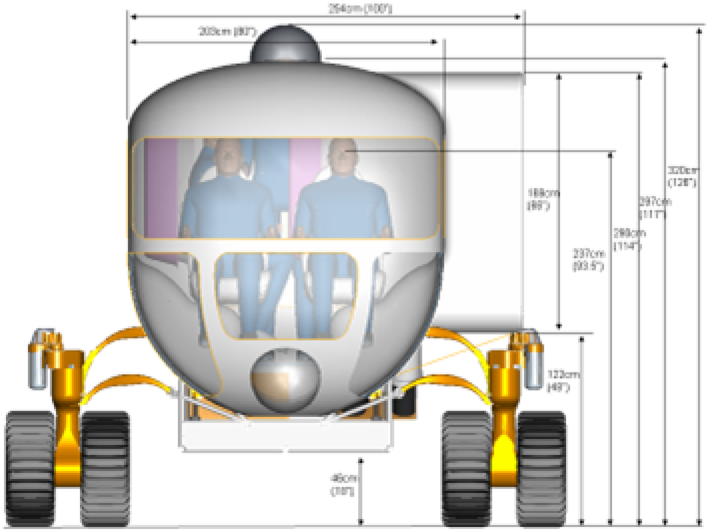


Current Small Pressurized Rover Design

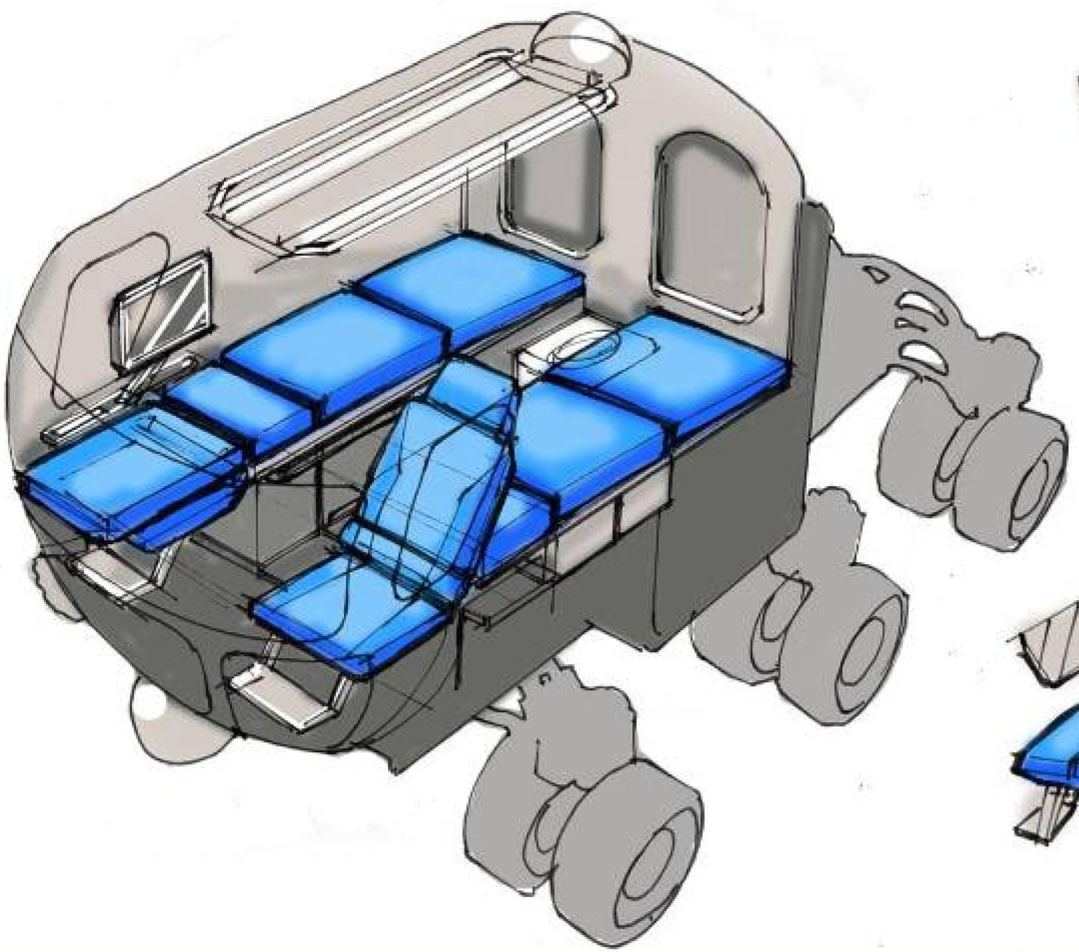


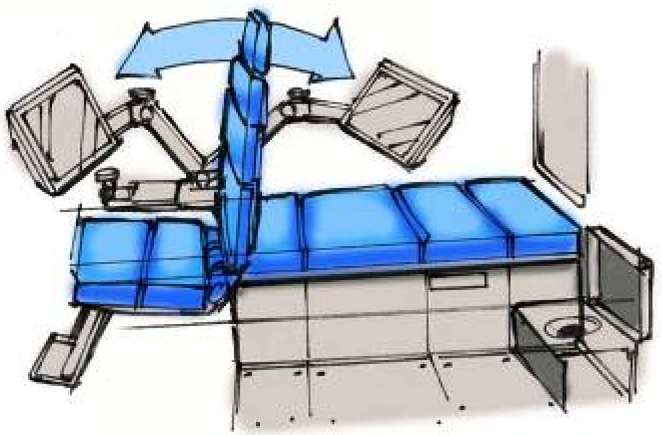
- Approximately half the size and mass of typical pressurized lunar rover designs – enables delivery of two or more pressurized rovers
- Suitports enable rapid ingress and egress with minimal gas loss
- Visual accessibility to geological targets comparable to EVA observations i.e. naked eyes ≤ 1m of targets
- Heat and humidity rejection provided by airflow through ice-shielded lock and condensing heat exchanger
- Ice-shielded lock



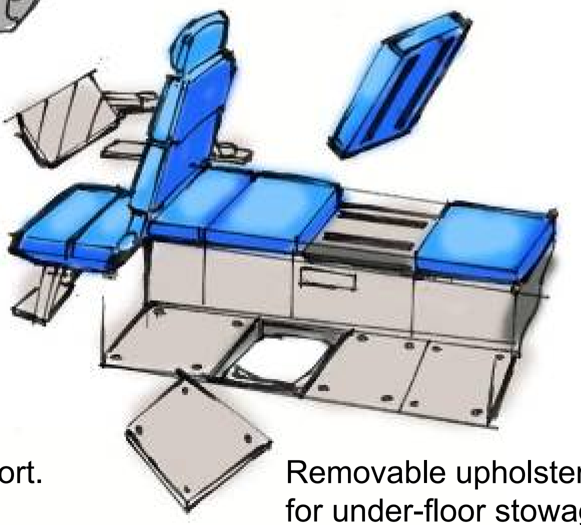


Current Small Pressurized Rover Design





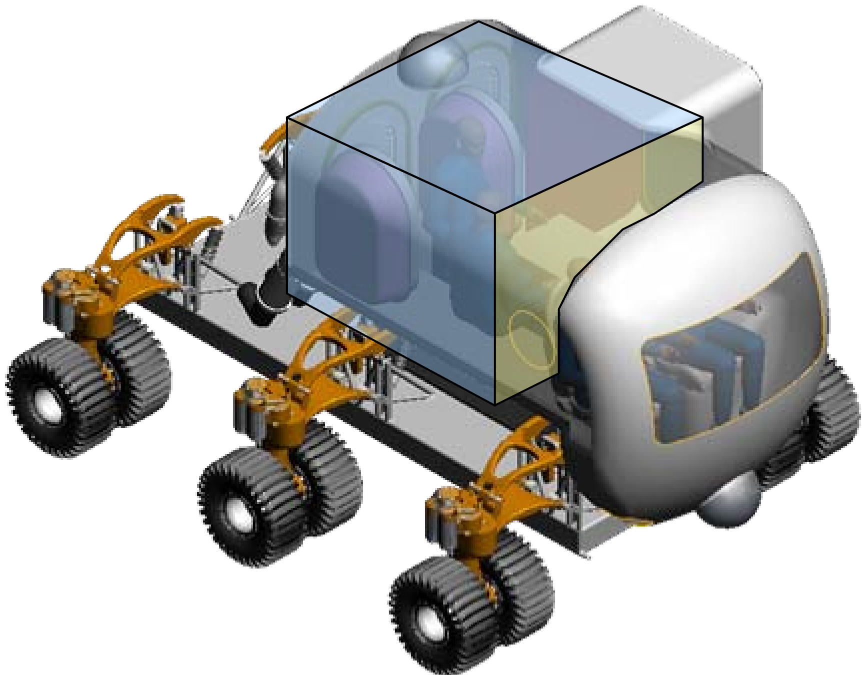
Seating and D&C convertible for use in either direction.



Smooth continuous surfaces increase perceived volume and crew comfort. Soft upholstery and versatile, adjustable surfaces for multiple uses.

Removable upholstery and panels for under-floor stowage.

Radiation Protection



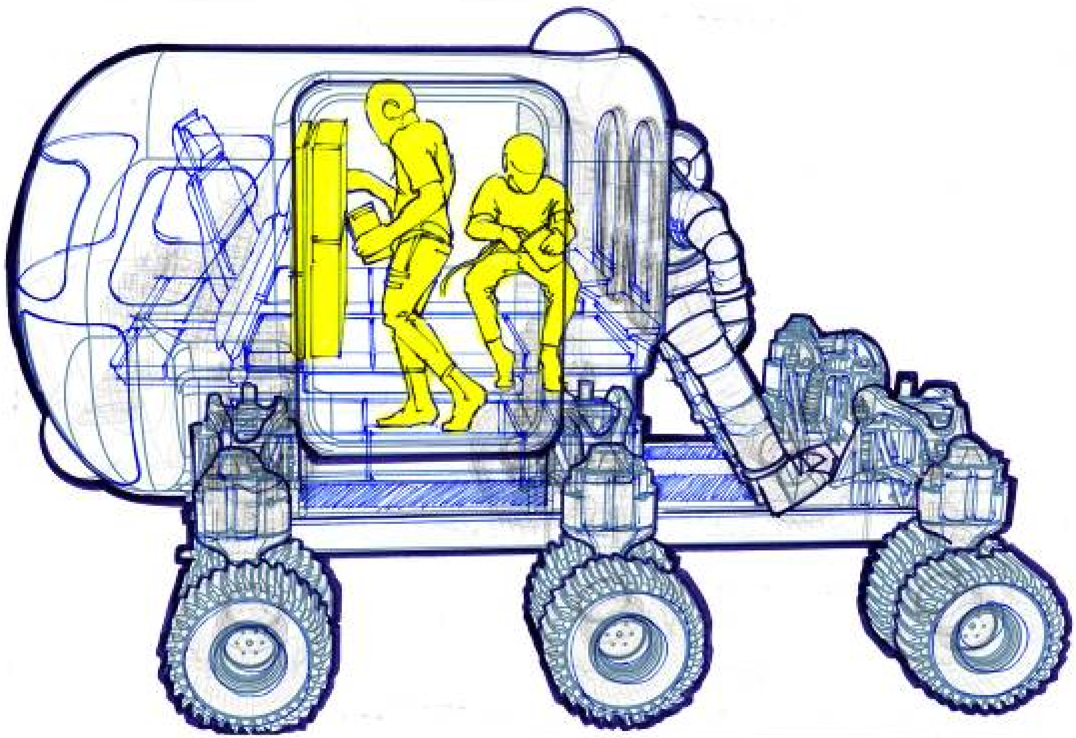
- Water and polyethylene shield will provide protection against Solar Particle Events (SPEs)
- Shielding will vary from 1.3cm to 5.3 cm (0.5” to 2.4”) with less shielding needed in areas where the central lock is also shielded by the rest of the SPR structure
  - Preliminary analysis based on reducing the effective dose (organ averaged) below 10cSv (Rem) for the historically largest SPEs
- Polyethylene shielding will be used for surfaces where the use of water shielding would interfere with interior layout during nominal operations or be complicated by other structures e.g. suitport hatches
- SPE safe haven in the SPRs should eliminate the need for dedicated SPE shielding in either the habitats

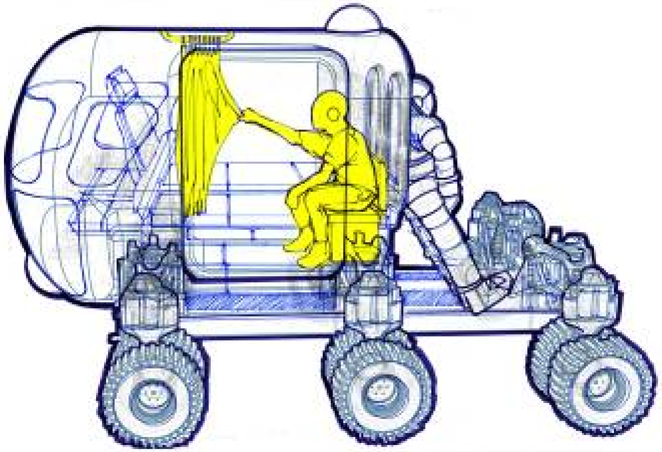
Suit-Induced Trauma

- Suit-induced trauma currently occurs with even minimal EVA time
  - Long duration missions with three 8hr EVAs per person per week
  - Apollo suits were used no more than 3 times
  - Individual crewmembers could perform up to 76 EVAs in a 6-month mission
- SPRs potentially reduce total EVA time by 50% or more - <u>with same boots-on-surface exploration EVA time</u> - because long translations are performed in SPR shirtsleeve environment and visibility is as good as EVA visibility
- Less time in EVA suit = less suit-induced trauma

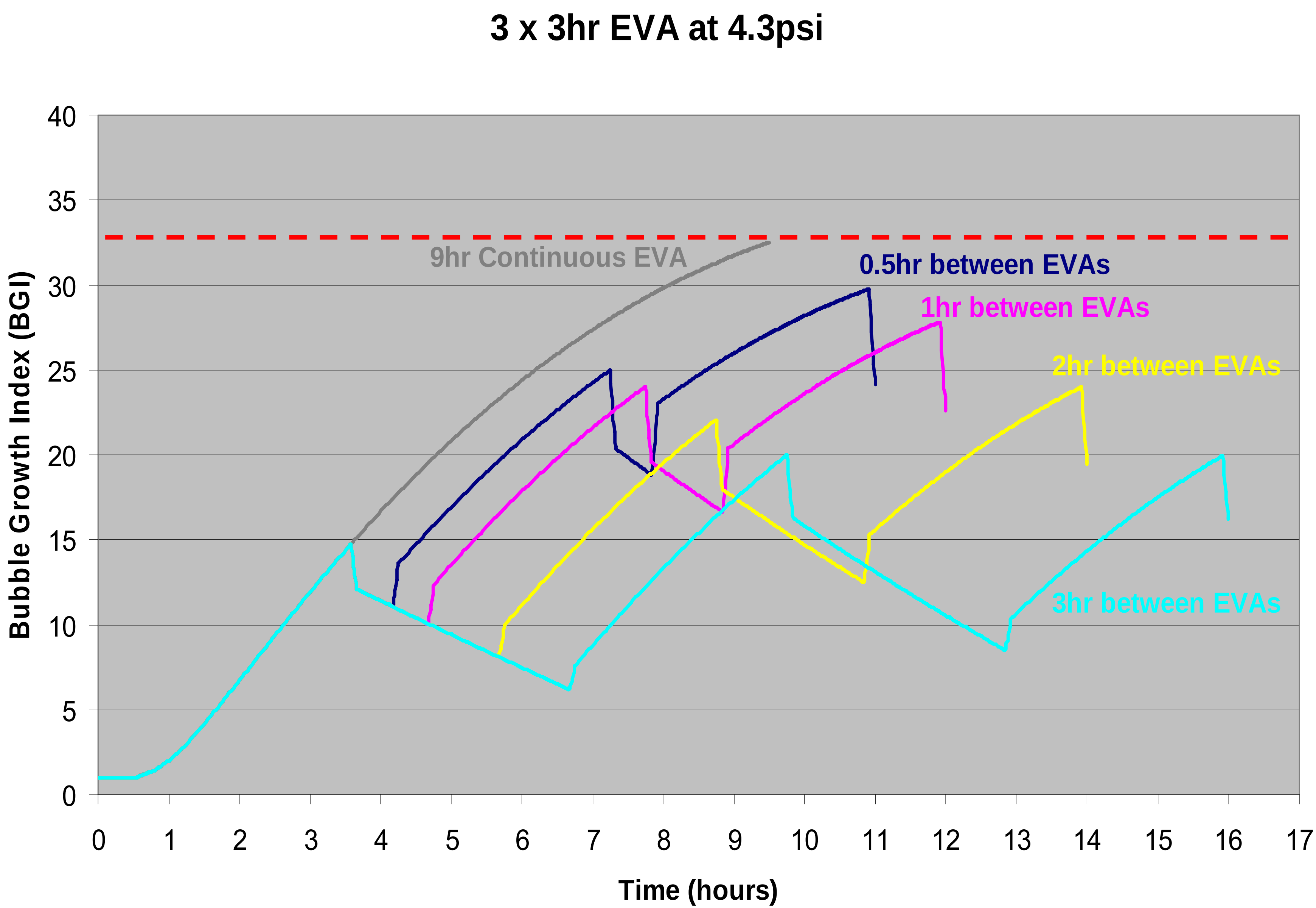
Improved Nutrition, Hydration and Waste Management Options

- Rapid ingress/egress capability enables IVA solutions for nutrition, hydration and waste management needs
- In current design:
  - Flip-up counter reveals food stowage lockers
  - Flash water heater access under counter for re-hydration of food items



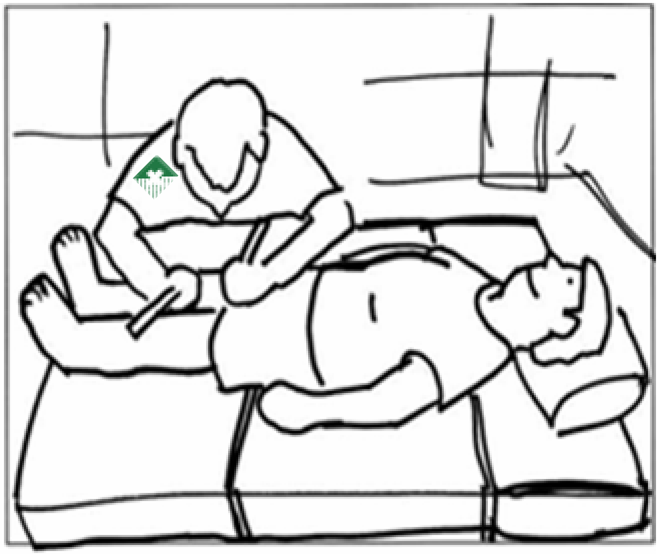


Reduced Decompression Stress



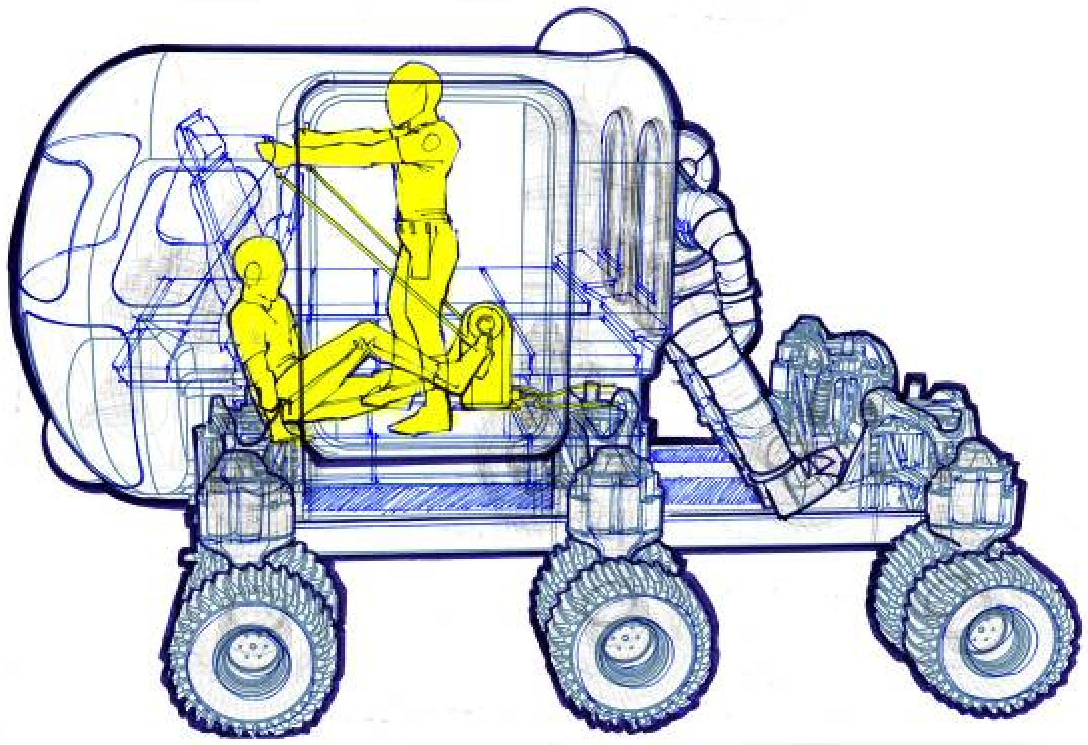
Pressurized Safe Haven for Treatment of Injuries or Decompression Sickness

- Crewmembers always within 20 minutes of a pressurized safe haven
- Enables treatment for decompression sickness and expedited on-site treatment/medication of injured crewmembers
- SPR will carry an expeditionary medical kit
- Medical capabilities of SPR will match the standards of care mandated by NASA requirements based on the duration of the expedition and the distance from the outpost
- Incapacitated crewmembers brought into SPR cabin using side hatch
- Two SPRs provides pressurized contingency return capability
  - With a single Large Pressurized Rover, contingency return capability would be provided by an Unpressurized Rover, which decreases contingency return range



Exercise Countermeasures

- Time spent inside SPR during long translations may be spent exercising
- Exercise device being designed to provide cardiovascular (up to 75% VO_2 peak) and resistive exercise capability
- Crewmembers' mechanical energy during exercise may be converted to electrical energy and used to help recharge SPR batteries



Conclusions

- Pressurized safe-haven providing SPE protection and decompression sickness (DCS) treatment capabilities within 20 mins at all times
- Up to 50% reduction in time spent in EVA suits (vs. Unpressurized Rovers) for equal or greater Boots-on-Surface EVA exploration time
  - Reduces suit-induced trauma and provides improved options for nutrition, hydration, and waste-management
  - Time spent inside SPR during long translations may be spent performing resistive and cardiovascular exercise
- Multiple shorter EVAs versus single 8 hr EVAs increases DCS safety and decreases prebreathe requirements
- SPRs also offer many potential operational, engineering and exploration benefits not addressed here


Questions?

Backup

Acknowledgements