Habitat Demonstration Unit-Pressurized Excursion Module

NASAfacts

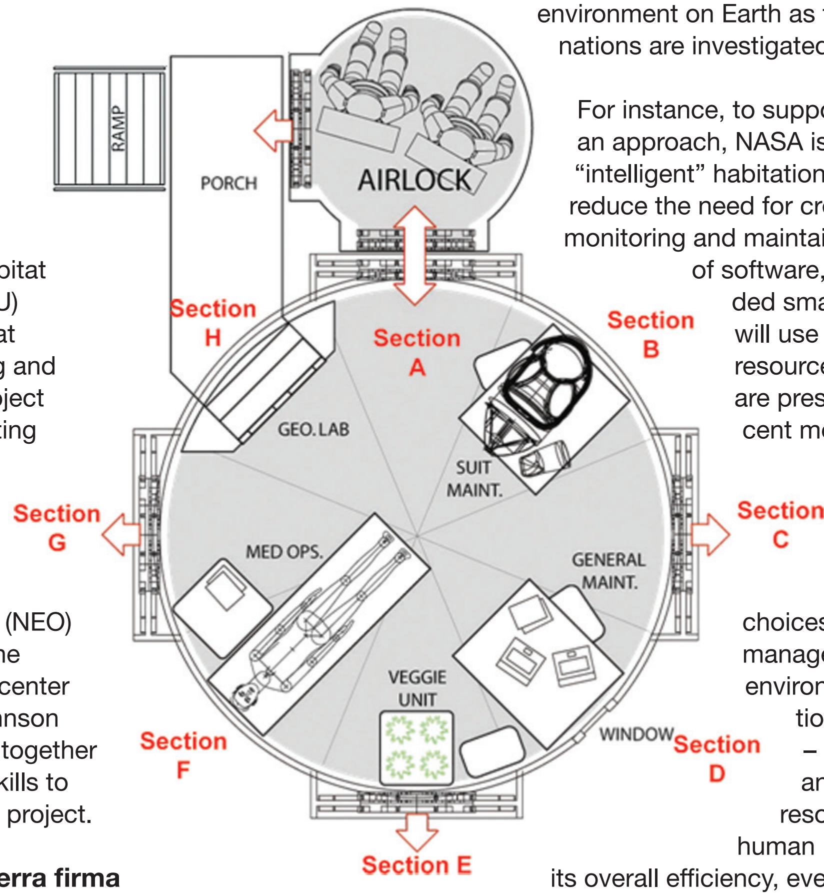
Even in space, there's no place like home

Regardless of what surface they're exploring, at the end of a long day collecting geological samples or performing scientific experiments astronauts need a base of operations to return to. NASA architects, engineers and scientists are already busy creating exactly that – sustainable, off-Earth living quarters, workspaces and laboratories for next-generation space missions. The knowledge gained from low-Earth orbit projects, such as the International Space Station, and Earth-based analog research from the Desert RATS (or Research and Technologies Studies) tests in Arizona is being used to figure out what is required to expand our presence to more distant environments, such as asteroids, near-Earth asteroids, Lagrange points, the moon or Mars.

Building a space habitat to maintain good physical and mental health during long-duration space missions is critical to long-term exploration. Incorporating safety features for the hazardous natural environment, supplying adequate air and water, providing waste disposal and recycling, maintaining physical fitness, regulating temperature and preserving food supplies are all issues that must be addressed as humans venture farther into space.

"An artist rendering of the Malapert excursion mission showing a Pressurized Excursion Module (PEM) integrated on the mobility Athlete system and two pressurized rovers."

NASA is preparing for future space travel by developing new intelligent operating systems and hardware. To determine whether new technologies meet their objectives, NASA has brought together the Habitat Demonstration Unit (HDU) Project to develop habitat configurations for testing and evaluation. The HDU Project provides flexibility in testing and evaluating configurations and operations for Human Exploration Framework Team-defined destinations such as near-Earth-orbit (NEO) and surface missions. The project employs a multi-center team, led by NASA's Johnson Space Center, that pulls together resources, people and skills to contribute to this unique project.



Testing for space on terra firma

The first habitat architecture to be used for testing is called the Habitat Demonstration Unit-Pressurized Excursion Module, or HDU-PEM. The module will be placed in space-like locations and situations, called analog environments, so engineers and scientists can test multiple concepts for operations and technologies simultaneously.

Providing a common platform for multiple NASA centers to synergize their technology advances, the PEM allows for the comparison of competitive operations concepts and technologies, and incorporates "green engineering" approaches. Advanced habitation systems tested in the PEM will ultimately be tested in future flight demonstrations.

But first, the HDU-PEM will be put through carefully controlled testing at the Johnson Space Center, and then in the Arizona desert, where the arid climate, harsh winds and rocky terrain provide a fitting analog for extra-planetary surfaces in the annual Desert RATS tests.

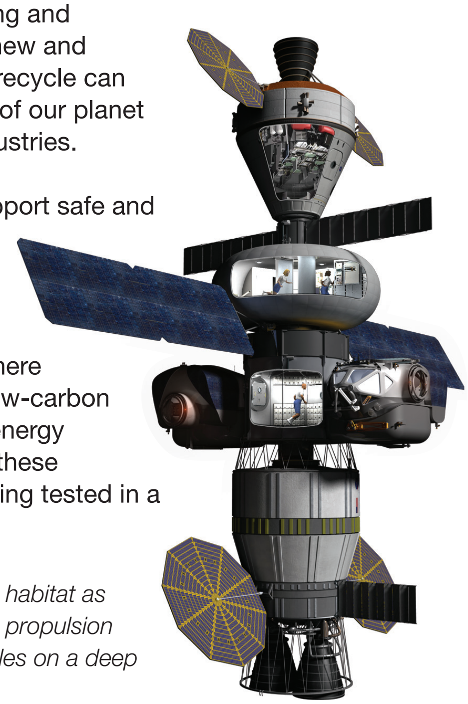
Flexible and beneficial

NASA's current plan for exploration calls for a "flexible path" approach, in which humans would visit sites never visited before and extend our knowledge of how to operate in space while traveling greater and greater distances from Earth. This also facilitates the development of many new technologies that could benefit daily life and the environment on Earth as future space travel destinations are investigated.

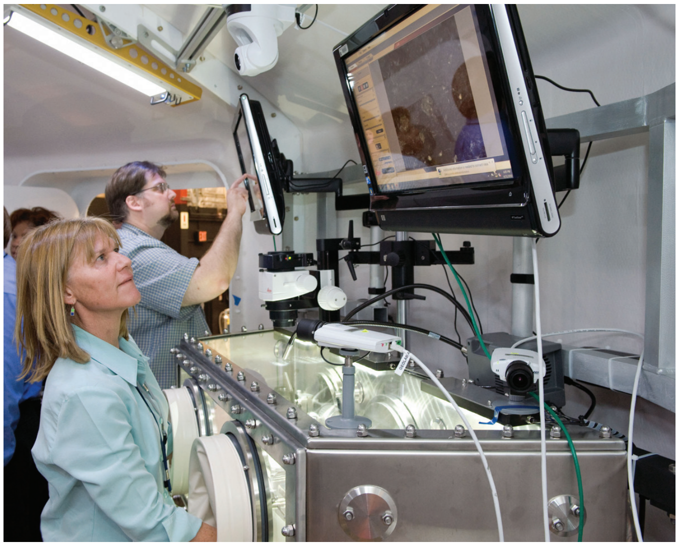
For instance, to support the flexibility of such an approach, NASA is developing advanced "intelligent" habitation systems that will reduce the need for crew and ground control monitoring and maintaining habitats by means of software, controls and embedded smart sensors. This system will use sensors to provide resources only when occupants are present, going into quiescent mode when no one is in the habitat, much like "green" buildings here on Earth. And, by implementing intelligent design choices and effective resource management and by choosing environmentally smart applications, an intelligent building – or habitat – can balance living space, power, resource management and human productivity to maximize its overall efficiency, even after the crew arrives. Mastering these challenges could make dense urban living here on Earth more aesthetically desirable.

In addition, the habitat will be used to evaluate the feasibility of a design approach called logistics-to-living, in which the packaging and logistics systems used to deliver supplies in space are recycled and repurposed into useable elements of the habitat or laboratory, such as furniture, outfitting and partitions. Finding new and innovative ways to recycle can increase the health of our planet and create new industries.

Technologies to support safe and efficient space habitats, with variable environmental conditions have already been used here on Earth to foster low-carbon footprint, net-zero energy buildings. Some of these technologies are being tested in a



A cutaway view of the habitat as it would integrate with propulsion and exploration modules on a deep space mission.



Cindy Evans and Mike Calaway demonstrate the GeoScience Laboratory Glovebox prototype.

building at NASA's Ames Research Center as a pathfinder. NASA wants to use these technologies in building new Leadership in Energy and Environmental Design (LEED)-certified office buildings at other NASA centers. This approach to "intelligent" buildings can be used for other government buildings, private industry and homes, greatly reducing operating costs.

Specifications

Non-Flight Shell: Eight composite fiberglass, resin-infused sections from a single mold, supported by large, C-shaped steel ribs

Structure: Cylindrical with a vertically oriented axis, on top of a 13.8-foot square cradle

Volume: 1,978 cubic feet (56 cubic meters) in one story

Size: 16.4 feet (5 meters) inner diameter; 10.8 feet (3.3 meters) high, total (6.6 feet barrel height with two 2.1-foot end domes on top and bottom)

Access: Three ports and one airlock

HDU-PEM Technology to be Tested at D-RATS 2010

NASA must advance the following technologies to become even more efficient and self-sustaining to support future travel off-planet. Testing conducted in the PEM will move these types of technologies forward, for use on Earth as next-generation "green technology," as well as in space.

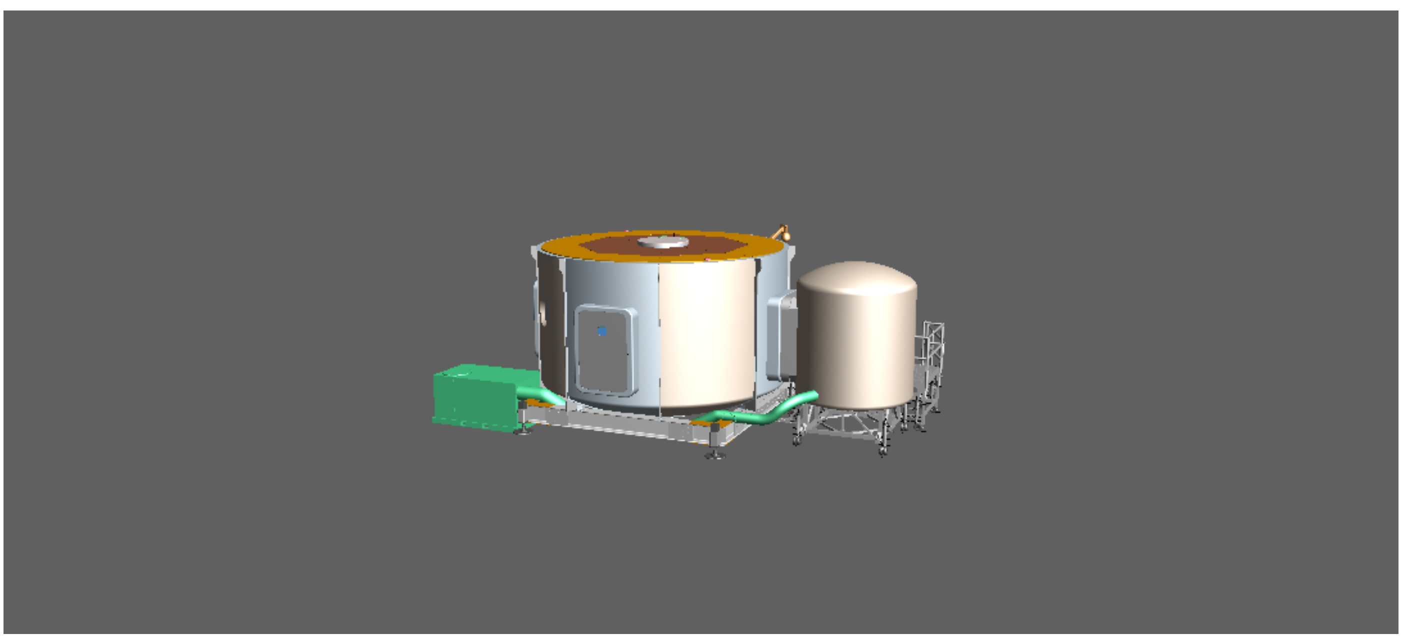
- "Intelligent" Habitat System Management Software
  - Build and evaluate intelligent software, integrated building systems health management, intelligent controls, intelligent sensors, and building management software and their ability to effectively and efficiently manage resources such as electricity, lighting, air, heating and cooling systems, communications, water and waste in the module. Back on Earth, all of these technologies will support the government's goals of sustainable energy and efficient use of resources.
- Power management systems – Demonstrate the HDU's more intelligent, safe and efficient power management system's power management control system, with individual monitoring for major energy-using devices for energy demand control.
- Spacewalk systems
  - Evaluate the hardware needs, volume requirements and operational concepts for assisting an incapacitated crewmember.
  - Evaluate volume of airlock concept involving spacesuit wipe down of dust, conducted externally and internally.
  - Evaluate efficiency of a grated floor versus a vacuum approach for dust mitigation.
- HDU core computing, networking and communications infrastructure – Evaluate segments of an integrated habitat network that will be used to command, control and monitor the critical and noncritical functions of a human habitat in an adverse situation.
- Wireless communication and radio frequency identification (RFID) – Reduce crew time spent on inventory management and locating lost or misplaced equipment or tools through use of wireless communication and RFID.
- Delay tolerant networking – Demonstrate technologies with the ability to capture data that would otherwise be lost during a power or communication disruption.
- Standards-based modular instrumentation system – Test of one type of technology to transmit data from multiple instrumentation inputs to the command and data handling system.
- Particle impact monitoring system – Integrate a test unit into one segment of the HDU, demonstrate the detection capabilities in low-speed regime (impact

occurrence, impact area, damage estimate), characterize the acoustic background environment, evaluate the optimal sensor configuration, test the signal processing software and identify any operations issues.

- Medical operations
  - Evaluate minimally medical-trained crewmembers' use of prototype medical kit and procedures.
  - Evaluate crew mitigation of medical issues using remote guidance from a simulated Mission Control-based flight surgeon.
  - Evaluate approach used to medically manage incapacitated crewmembers during a spacewalk.
- 2010 Geo-Science Lab – Test and evaluate the first geological laboratory integrated into an analog field-based facility. The lab includes a customized glove box equipped with sample pass-through chambers for sample transfers from outside, a microscope and X-ray instrument. The demonstration will help define advances needed for off-planet research.
- Dust protection – Conduct various tests involving dust-resistant coatings and electrostatic dust mitigation to advance knowledge on the topic.
- Food production – Demonstrate the use of a plant growth unit to augment crew diet with fresh produce on exploration campaigns.
- Light-Emiting Diode (LED) Lighting – Field test flight-hardware-quality, solid-state lighting modules, originally developed and flight-tested as a prototype for the space station, operating on 120 Vdc with avionics control and manual dimmer switches for each lighting module.
- Habitability – Evaluate the size and configuration of the module and how those relate to tasks performed.

For online users, click and drag over the graphic below to view the habitat at different angles.

Find the interactive version at http://www.nasa.gov/exploration/analogs/desert_rats.html



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