Keeping Animals in Space – Teacher Notes

As this lesson is primarily focused on brainstorming the requirements for animal habitats in space the background information covers some of the habitats actually used on space missions.

A habitat is the natural environment in which an animal will live. It is not restricted to the animal's home but includes all the land an animal needs to hunt, find food, find a mate and raise a family. Different combinations of light, air, soil and water along with climate and topography form different habitats.

The four key components of an animal's habitat are food, water, shelter and space. Different animals require different amounts of space or territory. Due to housing needs for the animals and to ensure that the correct conditions are maintained a large amount of consideration and planning goes into taking animals into space. Generally the simpler the form of life the easier it is to keep in space. There is substantial design and engineering effort employed in developing the correct habitat for the animals; they must be supplied with an artificial environment providing everything they need to survive while the habitat must be kept to minimum size and weight to be carried into space.

All of the animal payloads that have been carried on the Space Shuttle have been housed in the mid-deck area or within a laboratory module configured for the cargo bay. The orbiter mid-deck area is the housing option most frequently used when rodents are carried into space. The mid-deck has 42 lockers that can be used for experiments and payloads. When rodents are going to be launched on the Space Shuttle one to three of lockers are reconfigured with Animal Enclosure Modules (AEMs). These are the habitats in which the animals will live.

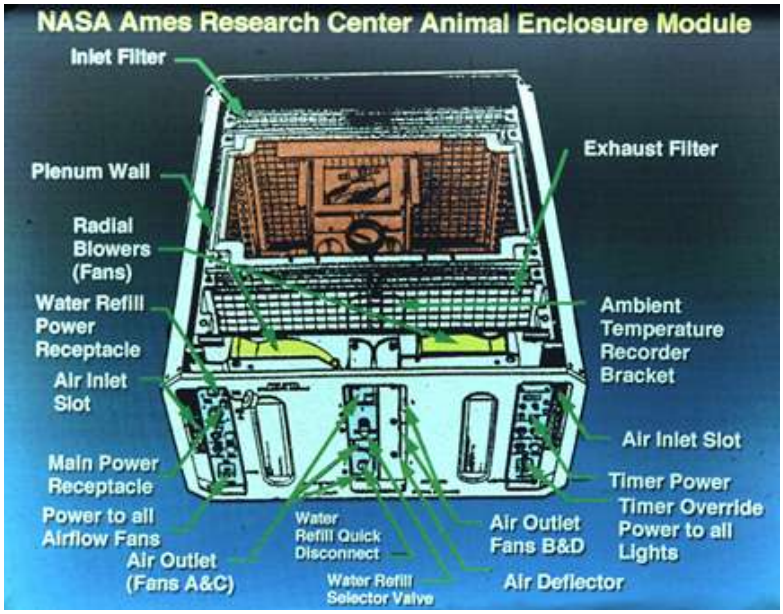


Figure 1: Schematics of the AEM

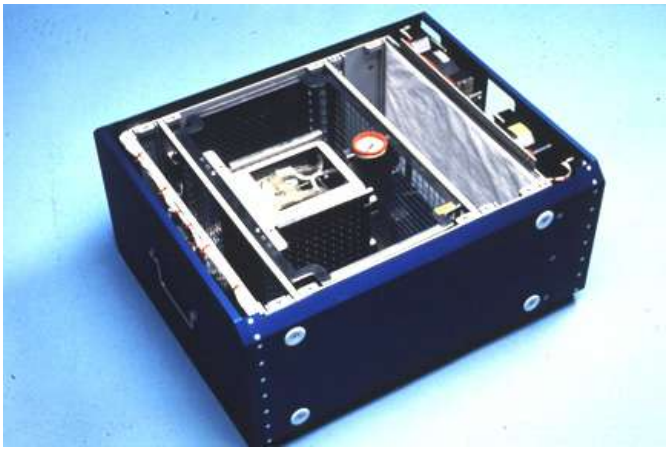
The AEM is used for investigations to study the influence of microgravity on rodent physiology, so far it has been used on 23 Space Shuttle missions. The AEM is a self-contained habitat that provides its occupants with living space, food, water, ventilation, and

lighting. The unit's internal waste management system is designed to keep the animals isolated from their waste by-products and to prevent these by-products and food crumbs from escaping into the Space Shuttle's habitable environment.

The AEM supports up to five adult rats or eight adult mice. It is composed of a stainless steel grid cage module, fan blowers, a layered filter system, interior lamps, food bars and a water unit. Total animal floor space, with water box installed, is 645 cm^2.

The AEM can be thought of as a miniature laboratory facility as it contains all the components necessary for maintenance of the animals during flight. The AEM remains in the stowage locker during launch and landing. During a mission the AEM can be removed it from the locker and the astronauts can observe or photograph the animals through a clear cover.

Cabin air is exchanged with the AEM through a filter system. Four fan blowers cause air to pull animal waste products into a collection filter. Cabin air is drawn through the front panel inlet slots and directed though the inlet filter located at the rear of the AEM into the animal habitat. Special filters prevent any microbiological escape into the cabin atmosphere. Treated charcoal, within the unit, confines animal odors within the closed system. Four internal lamps are controlled by an automatic timer to provide a programmable lighting cycle for the AEM. The timing of the day/night sequence can be selected, and is typically set to a 12/12-hour day/night cycle. Water consumption can be monitored in flight by observation of water levels via a window on the top of the water box and refilled as necessary. Rodent food bars are attached to four slide-in food bar plates inside the rodent cage. The food, a sterilized laboratory formula, is molded into rectangular bars accessible to the animals at all times during the mission.



The AEM is 24.50 x 43.69 x 51.05 cm and weighs approximately 27.2 kg (with food, water, and animals). The AEM requires a minimum of 35.5 Watts of power from the Space Shuttle. The temperature of the AEM is not controlled but is reliant on the temperature of the mid-deck.

Figure 2: The AEM

Another module used for carrying animals into space is the Spacelab module developed and built by the European Space Agency. The Spacelab module is carried in the orbiter cargo bay when it is flown. This laboratory converts into an on orbit research station that provides

ample space for rodents and non-human primates. The Research Animal Holding Facility (RAHF) can be carried in Spacelab and provides space for up to 24 rats or four squirrel monkeys.

The RAHF again provides a total self contained habitat for the animals including environmental control, food, water, light and waste management. Unlike the AEM the animals within the RAHF can be removed and taken to a work station where the cages can be opened and the animals handled for tissue or fluid collection, administration of treatments or euthanasia.

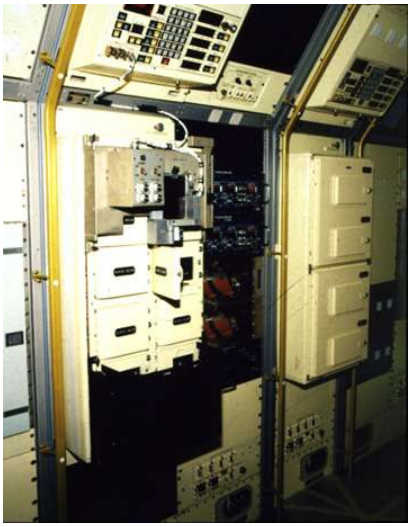


Figure 3: The RAHF in Spacelab module

Each cage provides a habitat space of 10.8 x 10.8 x 26 cm. They use bars similar to those in the AEM for a food source for rodent cages and special pellets to feed the primates. A similar water tank system is used to provide water to the habitat and can be refilled by the astronauts.

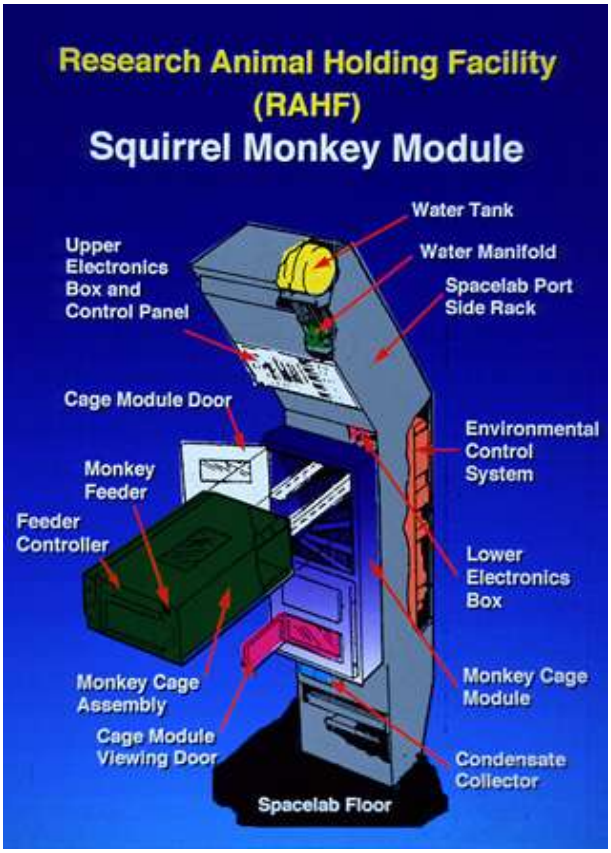


Figure 4: The Squirrel Monkey Module with the RAHF

The Environmental Control System on the back of the unit circulates conditioned air through the cage to control temperature and humidity, and to remove CO2 and replenish oxygen by exchange of air with the Spacelab. The RAHF modules contain monitoring systems that monitor general animal movement using an infrared light source. The RAHF also contains a data recording system to record temperature, humidity, water pressure, air flow, food eaten, water consumed and animal activity something that the AEM does not do. A similar system to the AEM provides a day/night lighting cycle.

There have been a large variety of animals sent into space and each animal requires different conditions this has meant that other purpose built habitats have been sent into space aboard the Space Shuttle. These include the BEM (Bee Enclosure Module) which carried 3400 honey bees along with a queen into orbit to observe whether they would produce honeycomb in microgravity. Even fish have been carried into space in specially designed fish tanks.

Figure 5: A fish aboard the Space Shuttle

The Space Station biological research program is the main life sciences research to be undertaken on the International Space Station. So far there are plans for advanced habitats to be built for rodents, fish, quail, fruit flies as well as habitats for growing plants and micro-organisms. The space station will also contain a centrifuge in which habitats could be placed to simulate 1 'g' of gravity.