Advanced life support systems will be essential to enable human planetary missions as outlined in the Vision for Space Exploration. Innovative, efficient, and practical concepts are needed for regenerative air revitalization, ventilation, temperature, and humidity control. Requirements include safe operability in micro- and partial-gravity, ambient and reduced-pressure environments, high reliability, regeneration and minimal use of expendables, ease of maintenance, and low-system volume, mass, and power. Proposals should explicitly describe how their work is expected to improve power, volume, mass, logistics, crew time, safety and reliability, with comparisons to existing state-of-the-art technologies. Information and documentation on advanced life support systems can be found at http://advlifesupport.jsc.nasa.gov.

### Air Revitalization

The management of cabin atmosphere in spacecraft and habitats includes concentration, separation, and control techniques for oxygen, carbon dioxide, water vapor, particulates and trace chemical components. This includes processing and recovering resources derived from waste streams and from \textit{in situ} planetary resources. Technologies focused at closing the air loop will have higher priority. Areas of emphasis include:

- Atmosphere revitalization process integration to achieve energy and logistics mass reductions;
- Separation of carbon dioxide from a mixture primarily of nitrogen, oxygen, and water vapor to maintain carbon dioxide concentrations below 0.3% by volume;
- Recovery of oxygen from carbon dioxide including approaches to deal with by-products of the process;
- Regenerable processes for removing trace chemical components from cabin air and/or gas product streams from other systems (e.g., water reclamation, waste management, etc.);
- Regenerable, re-usable, particulate filters for air;
- Novel approaches to suspended particulate matter removal from cabin and habitat atmospheres, including approaches to isolating cabin and habitat living areas from external dust sources such as Martian or lunar soil; and
• Methods of storage and delivery of atmospheric gases to reduce mass and volume and improve safety.

Advanced Thermal Control Systems

Thermal control is an essential part of any space vehicle, as it provides the necessary thermal environment for the crew and equipment to operate efficiently during the mission. A primary goal is to provide advanced technologies for temperature and humidity control; however, advanced active thermal control also includes technologies in the areas of heat acquisition, transport, and rejection. Areas of emphasis include:

• Liquid-to-liquid heat exchangers that provide two physical barriers preventing inter-path leakage;
• Advanced technologies to control cabin temperature and humidity in microgravity. Condensate that is collected must be able to be recovered and transported to the water recovery system;
• Alternate methods of atmospheric humidity control that do not use liquid-to-air heat exchanger (dependent on the spacecraft active thermal control system) or mechanical refrigeration technology;
• Technologies to inhibit microbial growth on wetted surfaces. Applications include condensate collection surfaces for humidity control and heat exchangers resident in water loops;
• Lightweight, versatile, and efficient heat acquisition devices including flexible cold plates, to provide cooling to electronics, motors, and other types of heat producing equipment that is internal to the cabin;
• Lightweight, controllable, evaporative heat rejection devices that can operate in environments ranging from space, Mars’ atmosphere, and Earth’s atmosphere;
• Alternative heat transfer fluids that are non-toxic, non-flammable, and have a low freezing temperature;
• Energy storage devices that maintain the integrity of food or science samples. For maintenance of temperatures of -20°C, -40°C, -80°C or -180°C;
• Highly accurate, remotely monitored, in situ, non-intrusive thermal instrumentation; and
• Low-energy, low-noise, high-capacity fans or similar devices for moving air.

Component Technologies

Energy efficient, low mass, low noise, low vibration, or vibration isolating, fail-safe, and reliable components for handling gases, fluids, particulates, and solids applicable to spacecraft environmental control and air revitalization, including actuators, fans, pumps, compressors, coolers, tubing, ducts, fittings, heat exchangers, couplings, quick disconnects, and valves that operate under varied levels of gravity, pressure, and vacuum. Mass flow monitoring and control devices that have similar attributes and that are easily calibrated and serviced.