In preparation for future human exploration we must advance our ability to live and work safely in space, and at the same time, develop technologies to reach the Moon and other planets. The objective of this subtopic is to introduce new technology in the form of devices, models, and/or instruments for use in microgravity, extraterrestrial habitats, and/or for commercial applications on Earth. Research should target spacecraft and planetary life-support systems (such as Extra-Vehicular Activity suits, extraterrestrial habitats, oxygen generation, and waste disposal), environmental monitors, and hazard controls (contaminants, fire safety, etc.). For Biofluids, please see subtopic B1.04 Bioscience and Engineering.

Innovations are sought in the following areas:

- Understanding the effects of microgravity on fluid behaviors.
- Using the mechanics of granular materials to determine how the reduced gravity environment affects transport and mixing of granular solids, with application to in situ resource utilization (ISRU) and more efficient terrestrial processes.
- Pool and flow boiling systems or subsystems that enable safe, efficient, and reliable heat transfer technologies for space application of advanced power and thermal control systems.
- Multiphase flow and fluid management to provide designers key information on controlling the location and dynamics of liquid–vapor interfaces in microgravity. This is needed for safe and reliable fluid handling and transport in microgravity.
- Innovative concepts for phase separation and condensation over a wide range of vapor content and gravity levels ranging from 0–1g.
- Measuring the residual accelerations on spacecraft or in ground-based low-gravity facilities. Emphasis is placed on MEMS or nanoscale devices capable of measuring quasi-steady (low frequency ~0–0.1 Hz) microgravity levels.
- Improving in-space system performance that relies on fluid or combustion phenomena, principally spacecraft fire safety, especially fire prevention, smoke, precursor, and fire detection and fire suppression.
- Characterization of ignitability, flame spread, and spacecraft material selection.

- Micropumps and microvalves, individual as well as simultaneous diagnostics for determining fluid movement through microscale devices for the aforementioned applications, and identifying specific chemical or biological elements of interest.

- Micropower systems for EVA operations, including power, heating, and cooling.

- Robust sensors for detection of hazards (fire, spills, leaks) in spacecraft, extraterrestrial habitats, and EVA systems.

- Partial and low-gravity compliant reactors for waste stabilization, as well as for oxygen and water recovery on extraterrestrial habitats.

- Understanding the effects of microgravity on combustion behaviors.

- Pollution reduction and improvement of the efficiency of liquid fueled combustors.

- Microfluidics for fuel cells and other power systems.