Decades of experience in manned space flight have demonstrated that during any mission, unexpected events will occur. If the crew is adequately equipped to address such contingencies during exploration missions, the chances of successfully completing that mission can be greatly increased. The objective of this subtopic is to develop technologies in the areas of fire prevention, detection, and suppression (FPDS) and in situ fabrication and repair (ISFAR) that will support the crew in the event of a fire or if a critical component breaks during a mission, respectively. These technologies may be in the form of devices, models, and/or instruments for use in microgravity and/or for commercial applications on Earth. The top-level requirements for a viable technology include the reduction of system hardware weight and volume and increased hardware reliability, durability, and operating lifetime. Research conducted during the Phase 1 contract should focus on demonstrating the technical feasibility of the FPDS or ISFAR protocol/system and show a path toward a Phase 2-specific deliverable. The contractor will, when appropriate, deliver a demonstration unit of the instrumentation for NASA testing before the completion of the Phase 2 contract.

Fire Prevention, Detection, and Suppression

The objective of the Fire Prevention, Detection, and Suppression (FPDS) subtopic is to develop technologies that, when incorporated into the design philosophy and functional design of exploration vehicles and habitats, will quantitatively reduce the likelihood of a fire and reduce the impact to the mission should a fire occur. The element is composed of four major theme areas including: fire prevention and material flammability, fire signatures and detection, fire suppression and response, and analysis of fire scenarios. Innovations are sought in the following theme areas:

- Quantifying the effects of microgravity, 1/6-g (lunar) and 1/3-g (Martian) on the ignitability of materials and the subsequent flame spread, particularly related to determining relevant low-gravity behavior from normal gravity tests;

- Improving the performance of spacecraft fire safety systems through the development of advanced fire detection and suppression systems and strategies as well as predicting the effects of smoke and precursor generation and transport; and
Developing techniques for creating and analyzing the effectiveness of fire resistant materials and coatings, including fire prevention techniques, for spacecraft structures, radiation shielding materials, paneling, fabrics (cotton, paper, synthetics), foams, etc.

**In Situ Fabrication and Repair**

*In Situ* Fabrication and Repair develops technologies for life support system maintenance and integrated habitat radiation shielding fabrication with a focus on contingency response and maximization of *in situ* resource utilization to reduce launch mass and volume. The manufacture or repair of components during a mission is essential to human exploration and development of space. Fabrication and repair beyond low Earth orbit is required to reduce resource requirements, spare parts inventory, and to enhance mission security. Proposals are sought in the technical themes listed below:

- Application of Free Form Fabrication (FFF) methods to low gravity (3/8 and 1/6 g level) manufacturing of near net shape products and spare parts from *in situ* derived resources or provisional feedstock;
- Processes for extracting *in situ* resources into raw materials and feedstock for use with rapid prototyping technology;
- Extension of fused deposition methods to the use of binderless metal wire feed stock;
- Adaptation of ultrasonic consolidation methods to use narrow ribbon metal feedstock to reduce subsequent machining operations and waste;
- Novel and innovative *in situ* repair methods such as but not limited to: welding, composite repair, and self healing materials;
- Development of highly automated habitat construction methods that incorporates *in situ* materials on surface or primary structure may use *in situ* construction;
- Development of dust mitigation techniques applicable to planetary habitat construction;
- Integration of radiation shielding materials into habitat construction methods; and
- Innovative approaches for recycling of materials for secondary uses.