Advancing process technologies for key atmosphere revitalization (AR) functions will be essential for enabling future efforts to extend crewed space exploration beyond low Earth orbit. Specific process technology advancements are sought in the technical areas of regenerative CO$_2$ removal, process gas drying, regenerable particulate matter filtration and separation techniques, and photocatalytic processes for removing trace volatile organic compounds (VOCs) from cabin atmospheric gases. Specifics pertaining to each technical area are the following:

- **Advanced Sorbents for CO$_2$ Removal** - Development of robust, high capacity, regenerable CO$_2$ adsorbents that substantially reduce the energy required for regeneration, are resistant to material degradation (i.e., dusting, spalling) and are highly selective to CO$_2$ over moisture. Candidate sorbents must be capable of operating in either CO$_2$ venting (open loop) or CO$_2$ processing (closed loop) modes.

- **Passive Moisture Removal** - Development of advanced water vapor removal techniques from air streams that operate at near-ambient pressure and temperatures and with little to no energy costs. This may include the development of water-selective materials (e.g., membranes, adsorbents) that exhibit significantly higher efficiencies than current commercial products. Very dry air (-65 °C dew point) can be assumed to be available to aid in drying process stream (1:1 ratio). Candidate process technologies must be capable of either venting moisture to space or returning moisture to the cabin for subsequent recovery for crew use.

- **Particulate Management** - Long-life and self-cleaning particulate pre-filters are required to reduce crew maintenance time and eliminate the need for consumable filter elements. These units should be able to handle large surges of particles and operate over very long periods. They should also be self-cleaning in-place or off-line (in-place is preferable, and provide viable methods for disposing of collected particulate matter while minimizing or eliminating direct contact by the crew. Complete (100%) capture of particles 20 microns and larger is required. Targeted technologies should be compact and lightweight, and easily integrated with the spacecraft Environmental Control and Life Support Systems (ECLSS).

- **Photocatalytic Oxidation (PCO) for Trace Contaminant Control** - Technologies are of interest for photocatalytic oxidation of Volatile Organic Carbon (VOCs) completely to CO$_2$ and H$_2$O (i.e., complete "mineralization") without producing partial oxidation products such as aldehydes and/or organic acids. Catalysts that are activated not only by UV, but also the visible region of the solar spectrum to capitalize on the highly efficient blue LEDs or solar energy are desired. Concepts should minimize PCO reactor volume via improved catalysts and catalyst activity, improved UV illumination scheme and/or improved illuminated catalyst surface area-to-volume ratio.
Technology Readiness Levels (TRL) of 2 to 3 or higher are sought.

Potential NASA Customers include:

- Human exploration missions include: Low-Earth orbit, Earth's neighborhood (Earth-moon libration points, lunar orbit and surface, geosynchronous orbits, etc), Near-Earth Asteroids, Mars Missions (transit, orbit, moons and surface).

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