This subtopic addresses acoustic monitoring technologies for current International Space Station (ISS) and future long duration spaceflight missions. Specifically, this subtopic calls for proposals to develop and demonstrate acoustic sensor technology enabling real-time, remotely performed measuring and monitoring of sound pressure levels and noise exposure levels in long-duration space vehicles. These technologies are the building blocks towards a network of continuously monitored, real-time acoustic sensors providing sound pressure level information as a function of frequency and/or time at multiple locations. Additionally, these technologies shall provide:

- Typical sound level meter,
- Typical acoustic dosimeter processing and analysis functionality,
- Capability for hazard level alerting.

Current State of the Art: Acoustic monitoring is currently being performed on the ISS using a hand-held sound level meter (SLM) that is moved to 60 different locations where a 15 second measurement is performed. Each SLM survey session takes 2 hours of crew time, and the survey is performed once every 2 months, thus reduced crew time needed will be an important benefit.

Because of the length of the survey, only a portion of the ISS can be measured during a single session. Similarly, acoustic dosimetry at fixed locations is performed once every 2 months, but only at three locations for each session because of crew-time and hardware limitations. Advanced acoustic monitoring technology will provide the capability to allow for more frequent and directed acoustic measurements and will allow nighttime measurements. These benefits will permit more precise trending, environmental monitoring and will provide a better validation of acoustic models, i.e., we will be able to isolate the impacts of various operations or pieces of hardware.

Areas of interest: Current automated acoustic monitoring methods used in ground-based systems perform measurements in isolated areas, e.g., around airports. However, the technology employed is large and heavy,
using conventional data acquisition boards, transducers, and transmitters.

NASA seeks proposals for acoustic monitors for spaceflight vehicle applications that:

- Are miniaturized,
- Are lightweight,
- Integrate data acquisition, sampling, and processing into the sensor
- Transmit the processed data wirelessly,
- Low-power consumption
- Can be a part of a multi-sensor system

The functional SLM goal is to provide average sound pressure level measurements over a short time duration (e.g. 20 seconds) as a function of frequency. The functionality required includes:

- Type II measurement accuracy over the octave band frequency range from 63 Hz to 20 kHz,
- Dynamic range of 90 dB or better,
- 1/3 octave band frequency representation,
- Narrow band frequency representation with selectable frequency resolution.

The following SLM functionality is desired:

- Type I measurement accuracy over the octave band frequency range from 63 Hz to 20 kHz,
- Octave band noise floor of 10 dB re 20 micropascals
- Fractional octave (1/1, 1/3, 1/12) band frequency representation.

The functional Acoustic Dosimeter goal is to provide noise exposure levels and data logging, i.e., log of sound levels as a function of time. The functionality required includes:

- Type III accuracy over the audible frequency range,
- Logging of A-weighted Overall Sound Pressure Levels every 30 seconds for a period of 24-hours,
- Dynamic range of 90 dB or better.

The following Acoustic Dosimeter functionality is desired:

- Noise floor of 30 dB re 20 micropascals.

The goal for the hazard level alert functionality is to provide continuous acoustic monitoring with logic that sends a
signal (to trigger a non-auditory alert) if hazardous noise levels of 85 dBA and above are detected. This is a new crew-health related function that will reduce the crew’s risk for exposure to high noise levels, and will protect the crew in the case of an off-nominal noise event. The functionality desired includes:

- Perform continuous acoustic data sampling
- Send an electronic signal if noise levels are 85 dBA or above

The following hazard level alert functionality is desired:

- Pre-trigger capability so onset of hazardous noise is measured.

The technology from this SBIR subtopic is highly desired for use on ISS and for future long duration space missions for the long-term.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase II contract. For Phase II, a demonstration in the JSC Acoustics and Noise Control Lab (ANCL) is being requested so that testing can be performed in the ISS Acoustic Mockup. As a result, an SBIR testing facility waiver will be needed.

Potential Phase III activities are envisioned to be a demonstration of the sensor’s capability on board ISS as a Station Detailed Test Objective (SDTO)

Phase I Deliverables:

- Sensor preliminary design
- Breadboard microphone transducer (proof of concept)
- Test data showing acoustic performance of breadboard sensor
- Forward plan for sensor development, including plans for in-situ calibration
- The expected TRL at the end of Phase I is 3-5

Phase II Deliverables:

- Sensor design in flight-like package
- Test data showing acoustic performance of flight-like sensor
- Demonstration of multiple sensors in ground facility (NASA JSC ANCL)
• The expected TRL at the end of Phase II should be 6.