High Performance Iodine Feed System, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Busek is developing an advanced iodine feed system for Hall Effect Thrusters (HETs), ion engines, cathodes, and other plasma generators. The feed system features an innovative piezo driven valve that saves volume, mass, cost, and energy with respect to state of the art alternatives. The feed system also features a low mass plastic propellant tank that may be manufactured through additive processes. This allows low cost, complex shapes that can maximize the use of available space inside volume-restricted spacecraft. The feed system will be especially attractive for small spacecraft and CubeSats. Iodine stores as a solid and sublimates at modest temperatures as the molecule I2, which allows many benefits with respect to traditional Hall effect thruster fuels such as xenon and krypton. These advantages include higher storage density, lower storage pressure, the ability to test high power systems at space-relevant conditions in modest facilities, the capability to store propellant in space without active regulation, and the capacity to transfer propellant at low-pressure conditions in space. In a space-limited spacecraft, using iodine instead of state of the art xenon could increase available delta-V by a factor of three (3) or more. In Phase I, Busek developed a feed system featuring the advanced components, which was integrated into the iSAT spacecraft form factor. The system was then tested with an iodine compatible Hall effect thruster in relevant space conditions. In Phase II, an improved feed system will be designed, built and tested. Major Phase II technical objectives include developing an engineering model iodine resistant, piezo driven flow control valve, finalizing the feed system control architecture, identifying and evaluate commercial components to fill out the system, and building and characterizing the system. At the conclusion of the Phase II effort, engineering model valves will be delivered to NASA for further characterization.

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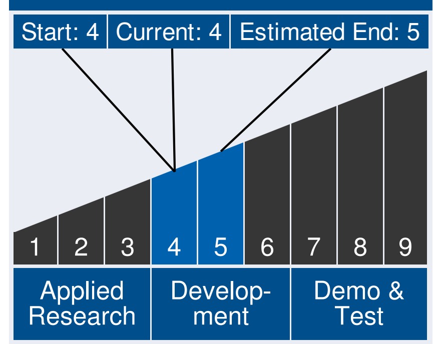
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed feed system supports iodine Hall thrusters, ion engines, hollow cathodes, and other plasma generators currently under development for NASA. Possible near term applications include the Iodine Satellite (iSat), Lunar IceCube, and follow-on missions. The Phase II feed system will be ideally sized for a Hall thruster operating at power levels of 100 W to 600 W, and for gridded ion engines operating at similar or lower power levels. These thrusters would be used for orbit raising and interplanetary transfers. Missions of current interest include resource prospecting at the moon, Mars, asteroids, and NEOs. The technology is applicable to spacecraft of all sizes from CubeSats to Asteroid Redirect spacecraft to future MW-class cargo transports supporting human exploration. The ability to flow iodine as a HET propellant is a the game changer. Iodine is efficient, compact, highly storable, and an order of magnitude cheaper than xenon. Full power thruster demonstrations and throttling in space conditions are feasible because iodine is efficiently pumped by liquid nitrogen cooled panels.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The proposed feed system supports many types of plasma generators used in space and on the ground. In the near term, the innovative feed system components are most likely to be used as part of a space propulsion system. Commercial and military applications for iodine propulsion include orbit raising, orbit circularization, inclination changes, station-keeping and repositioning. The next stage for commercial users is an all-electric satellite, where electric propulsion accomplishes all propulsion functions. Beyond stored density and pressure, iodine has many additional benefits with respect to xenon. For instance, a fully-fueled, non-active system may be stored on the ground or on orbit for long periods of time. This reduces the cost of on-orbit spares, and

Management Team *(cont.)*

Principal Investigator:

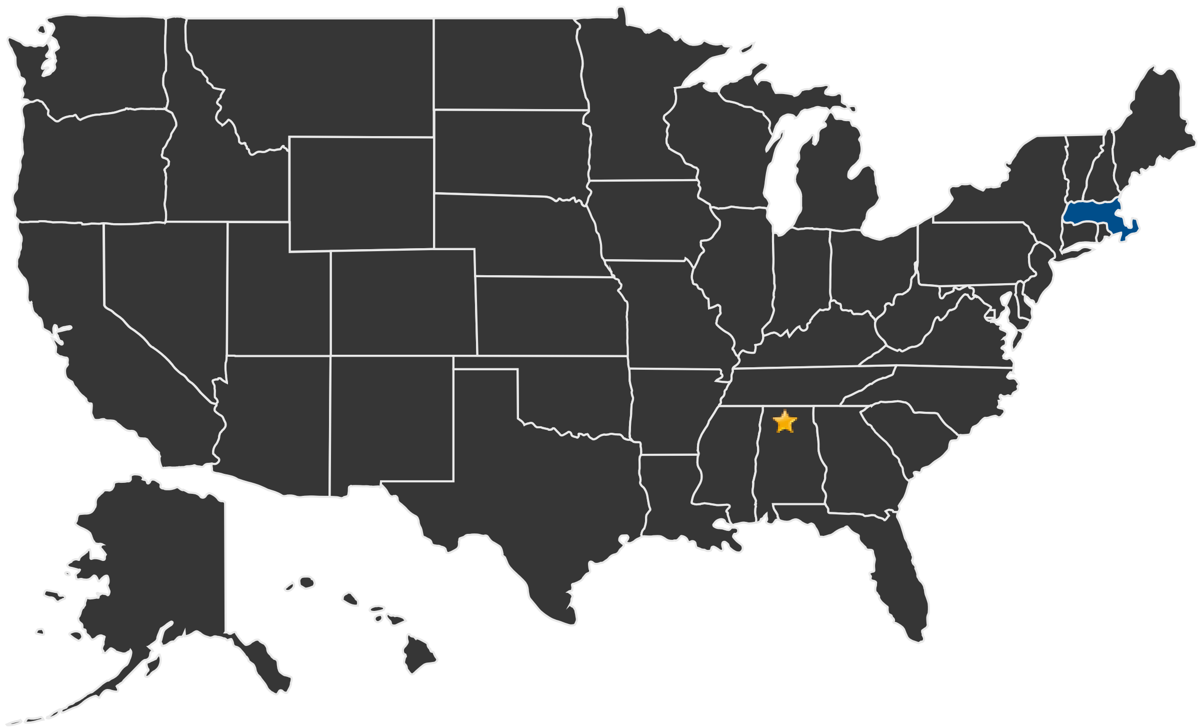
- James Szabo

Technology Areas

Primary Technology Area:
In-Space Propulsion Technologies (TA 2)
└─ Supporting Technologies (TA 2.4)
  └─ Propellant Storage and Transfer (TA 2.4.2)

minimizes down-time in the event of a failure. Low pressure on-orbit refueling is also feasible. Due to these and other advantages, iodine may be very attractive for commercial missions such as asteroid mining.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

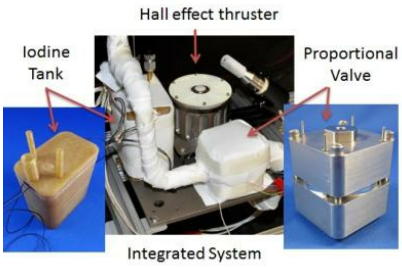
- Busek Company, Inc. (Natick, MA)

PROJECT LIBRARY

Presentations

- Briefing Chart
    - (http://techport.nasa.gov:80/file/23424)

IMAGE GALLERY



High Performance Iodine Feed System, Phase II

DETAILS FOR TECHNOLOGY 1

Technology Title

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