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Nuclear and future flight propulsion

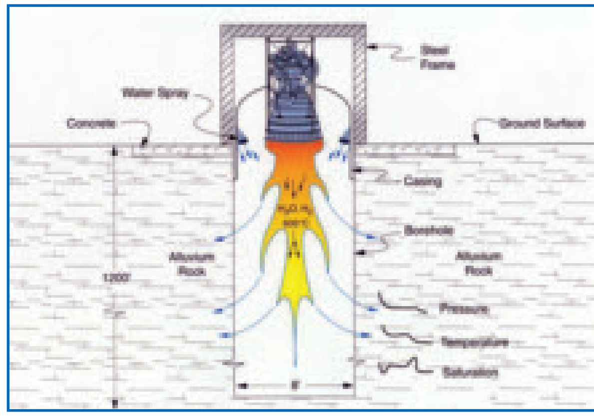
One attractive concept for nuclear and future flight propulsion is atmospheric mining in the outer solar system. The atmospheres of Uranus and Neptune offer very large amounts of atmospheric gases for nuclear rocket and air-breathing propulsion. Based on past studies by NASA Glenn, aerospacecraft cruisers have been identified as a 'best' solution for atmospheric mining.

To power these vehicles, atmospheric hydrogen gas would be liquefied and used as a rocket propellant for the ascent to orbit. Gaseous or liquid hydrogen would be used to power the engines during atmospheric mining operations. A closed-cycle gas core rocket propulsion option is a likely candidate for the aerospacecraft. Helium 3 would be separated from the atmospheric hydrogen, and helium 4 would be captured, liquefied, and stored as a payload to be returned to orbit. The helium 3 carried to orbit along with other hydrogen isotopes (such as deuterium) could power nuclear fusion vehicles for fast interplanetary and future interstellar flight.

Researchers have conducted studies of the gas capture rate and its influence on mining time in the atmosphere. During helium 3 capturing, large amounts of hydrogen and helium 4 are produced. Analyses were performed to quantify the mass production rates of these other potential fuels. For example, if the atmospheric capture rate were 4 kg/sec, the required amount—500 kg of helium 3—would be captured in 95.2 days. During that time, 293,000 kg of hydrogen would be produced per day. To fully fuel a 1,800-sec-I_{sp} nuclear gas core mining aerospacecraft, 270,000 kg is required. Therefore an enormous amount of excess hydrogen and helium 4 is produced each day.

Capturing the excess hydrogen and helium 4 to fuel additional exploration and exploitation vehicles was addressed as well. New options for fleets of aerospacecraft for exploration and exploitation missions are possible. Deep diving and far-ranging aircraft carried to the outer planets could be released from the main mining aerospacecraft to explore a diverse set of atmospheric targets.

With this added hydrogen and helium 4 resource, many vehicles could be fueled.



Schematic of the SAFE concept shows an NTR sealed over a standard hole at NTS.

Entire fleets of uninhabited aerial vehicles including balloons and rockets could fly through the outer planet atmospheres for activities such as global weather observations, localized storm or other disturbance investigations, wind speed measurements, and polar observations.

Extensive analyses of nearer term nuclear rocket options were also conducted this year. Planning for nuclear testing in the Nevada Test Site showed options for testing nuclear thermal rocket (NTR) engines while minimizing any release of exhaust gases into the Earth's atmosphere. A team consisting of the Center for Space Nuclear Research, Nuclear Security Technologies, the Desert Research Institute, Aerojet, and NASA Glenn addressed the methods of delivering and testing the NTR engines.

One major issue with developing an NTR for future missions is the ability to test the full system on the ground economically. In the late 1990s, the SAFE (subsurface active filtering of exhaust) concept was first proposed as a method for testing an NTR at full power and at full duration. The SAFE concept relied on firing an NTR into nuclear test holes at the Nevada Test Site, which had been constructed to test nuclear weapons. The estimate included preparation of the site (providing roads, power, and so on); drilling and casing of the four holes; constructing an earthen berm around the test site; installing the instrument trailers; placing the instrumentation in the diagnostic holes; installing the various gas tankers and the water cooling system; and constructing a safety fence.

by **Bryan Palaszewski**