Benefits Of Nuclear UAVs

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In March, Sandia National Laboratories released a summary of research it had conducted with Northrop Grumman's unmanned systems division concerning an "ultra-persistent propulsion and power system" for unmanned aerial vehicles (UAV). The conclusion was that UAVs could be built with longer endurance and lower operating cost than with hydrogen or hydrocarbon fuel, creating "unmatched global capabilities to observe and preempt terrorist and weapon of mass destruction activities."

An earlier Sandia study concluded that such a UAV could be tested within a decade. It will not be, because it is nuclear-powered, and politics make it impossible. But the technical and operational case is powerful.

Non-solar-powered UAVs, such as Boeing's hydrogen-fueled Phantom Eye and Aurora Flight Sciences' Orion, are expected to deliver multi-day endurance. But they cannot carry large payloads or provide much electrical power, and are slow, so have to be forward-based. They are also restricted to propeller propulsion, which makes stealth unattainable.

The Sandia-Northrop activity is linked to studies of nuclear-powered UAVs in the U.S. Air Force that started in the mid-1990s, not long after the Advanced Airborne Reconnaissance System, a conventionally powered long-endurance stealth drone planned in the 1980s to track Soviet mobile nuclear missiles, was terminated.

Sandia was heavily involved by 2001. A paper from the Center for Strategic and Budgetary Assessments noted that Sandia's Special Projects Department had proposed an "extremely long-endurance vehicle (ELEV)" or "air-breathing satellite." The ELEV could fly at 70,000 ft. and stay on station for six months to a year with up to a 5,000-lb. payload. According to Sandia, building a modern nuclear-turbojet engine "would not be an R&D project," the CSBA report stated, "but rather an engineering development effort that could culminate in a flight test within a decade."

Boeing's Phantom Works was involved with the design of the nuclear UAV, a high-subsonic, blended-wing body. Propulsion was based on concepts that emerged from the Airborne Nuclear Power (ANP) program of the 1950s, which was intended to lead to a strategic missile carrier that would remain on continuous airborne alert for a week or more. It combined two turbojet engines with a reactor. ANP looked at two designs: "direct cycle," in which the engine airflow cooled the reactor; and "indirect cycle," in which a liquid-metal coolant carried heat from the reactor to the engine.

The 2000-era UAV enjoyed three advantages over ANP, which struggled to reach a performance level where the aircraft could fly. Two stemmed from the fact that it was a UAV, which could take advantage of the propulsion system's endurance. Planners envisioned features such as magnetic engine bearings to eliminate oil. Importantly, more than half the weight of the ANP propulsion system was radiation shielding, which could be reduced in a system that would not run at full power near humans. (In the Sandia studies, the engines burned jet fuel for takeoff and landing.) A USAF study of a Global Hawk with a nuclear engine indicated it might need only 2,700 lb. of shielding.

The third advantage was improved reactor technology. Air Force interest in ELEV coincided with the winding-down of the Space Nuclear Thermal Propulsion technology program, in which Sandia was also involved. SNTP started in 1987 as the Strategic Defense Initiative Office's Project Timberwind, aimed at producing a nuclear-thermal rocket (developing thrust by superheating hydrogen) for a missile interceptor, but was canceled after the Cold War. A Timberwind rocket engine would have incorporated a particle bed reactor (PBR), with some designs weighing as little as 2,000 lb., using carbon-carbon and ceramic-matrix composites.

New reactor designs are safer. They "would only hurt you if they fell on you," it has been suggested, because of specially fabricated and shielded fuel elements and robust "poison" systems to perform an emergency shutdown. It is not known whether a PBR or a different modern reactor technology was the basis for the ELEV concept or the Sandia-Northrop Grumman study, which covered eight heat sources, three power conversion systems, two dual-cycle propulsion systems and an electrical generation system. However, it was stated in 2001 that the propulsion system would power the aircraft while delivering several hundred kilowatts to onboard radar, communications and electronic attack systems. Conventional turbine engines optimized for range and fuel consumption and sized for typical UAVs struggle to deliver 50+ kw at altitude.

Not that any of this matters. Politically speaking, the answer to the Louvin Brothers' musical challenge of the 1950s—"Are you ready for that great atomic power?"—is a resounding "no," particularly in a UAV.

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