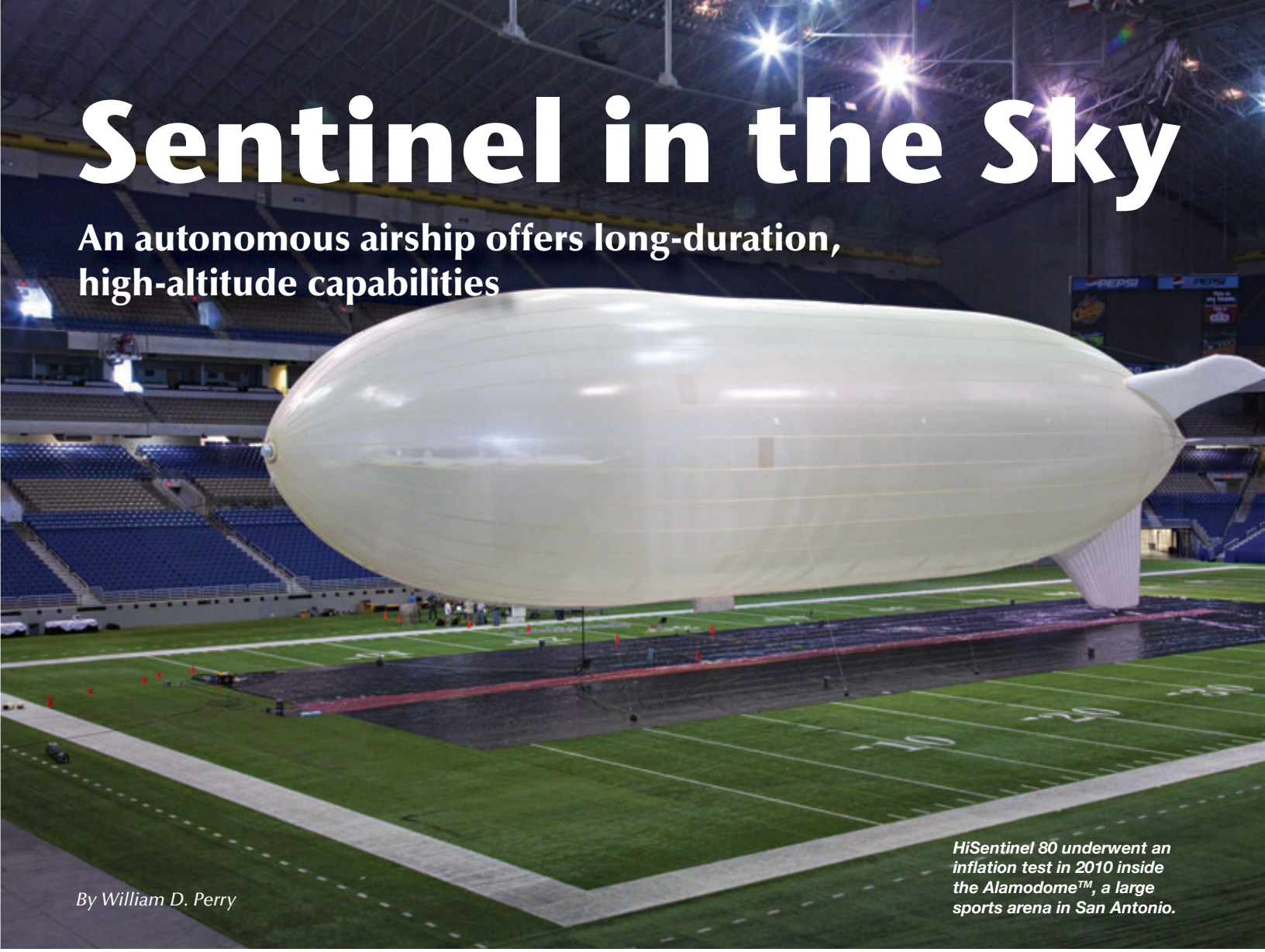
Sentinel in the Sky

An autonomous airship offers long-duration, high-altitude capabilities



HiSentinel 80 underwent an inflation test in 2010 inside the Alamodome™, a large sports arena in San Antonio.

By William D. Perry

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Modern wartime intelligence, surveillance and reconnaissance (ISR) are increasingly defined by autonomous systems that can deploy in a dangerous locale without placing a human operator at risk. This does not mean there is zero risk; unmanned vehicles and their vital missions still are vulnerable to enemy attack, hazardous weather conditions and mechanical malfunction.

To minimize this vulnerability, designers of autonomous, unmanned aerial systems seek a stealthy design and the least-threatening operating environment consistent with the mission at hand. For example, high altitude offers protection from attack and allows a wide view and above-the-weather operations. Designing a system to be unmanned frees the vehicle from the weight, size and ergonomic considerations associated with carrying a human, plus the sleep and food requirements that limit the duration of manned missions.

All of these qualities have been integrated into an experimental, unmanned aerial system whose appearance recalls a technology that has been out of military use for a half-century. However, this new concept, approach and construction are drastically different from the military blimps of old.

HiSentinel is a spiral development project to design a family of high-altitude, long-endurance airships for the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command. Southwest Research Institute (SwRI) engineers provide project management, overall vehicle and system design, flight command and control electronics and operations. Aerostar International, a commercial manufacturer of lighter-than-air vehicles, has designed the high-strength hull material, manufactured the airship hull and provides test operations support. These autonomous airships can be stored in a shipping container instead of a hangar and launched from a parking lot or an open field rather than an airbase runway. They can be programmed and launched in a matter of hours, yet remain aloft continuously for weeks using solar panels to charge batteries that power the instruments and an electric motor-driven propeller. Low-cost and expendable, HiSentinel airships can provide long-duration tactical platforms for military and homeland security applications including surveillance, communications and sensor payloads.

From an operating altitude 13-15 miles above the Earth, the field of view is a circle 600 miles in diameter, roughly the straight-line distance from Brownsville to New Orleans on the Gulf Coast, or from

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San Diego almost to El Paso on the U.S.-Mexico border. Such coverage by a single vehicle reduces the number of unmanned aerial vehicles needed on-station during operations. When used as a communications relay platform HiSentinel can significantly boost the range of low-powered, hand-held communication devices.

Designed for simplicity

HiSentinel's gas envelope is constructed of a thin, lightweight but strong fabric with an integral plastic gas barrier. It can be folded into a small cube-shaped shipping container but inflates to a length of 200 feet and a diameter of 45.5 feet at altitude. Its envelope is partially inflated at launch and ascends as a flaccid balloon. The helium inside expands to fill the structure as the airship ascends and the outside atmospheric pressure decreases. When the airship reaches the predetermined flight altitude the envelope and tailfins pressurize to form a rigid, aerodynamic shape.

HiSentinel 80 is powered by an electric motor that can propel it at the designed cruise speed of 18 knots (21 miles per hour) or allow it to remain over a stationary point by counteracting the winds aloft. Once a mission is completed, the airship can navigate to a new location or be "parked" in a set location at altitude while waiting for its next mission. As each mission is completed, the airship will remain aloft, waiting for the next assignment. When the flight needs to be ended it will be flown to a convenient recovery location where the flight systems and payload will separate from the expendable hull and return to Earth beneath a parachute or guided parafoil.

A three-segment equipment pod suspended beneath the gas envelope includes a forward segment for batteries and a parachute, an aft segment for communications and flight electronics, and an interchangeable payload segment that accommodates up to 80 pounds of cameras, sensors and communications gear. The vehicle's mass, including payload, is 1,116 lbs. The airship's low cost, minimal need for launch and ground support, and long flight duration enable hourly costs estimated at $1,200, including flight and ground operations, compared to $13,000 per hour for a Global Hawk unmanned aerial vehicle and about $33,000 per hour for a high-altitude manned aircraft such as the U-2 .

Development and evaluation

HiSentinel 80 is the third airship of the latest generation of autonomous, high-altitude vehicles developed by the SwRI team since 1996. Three first-generation airships called SOUNDER were built and tested, followed by two second-generation airships designated HiSentinels 20 and 50. A flight test of HiSentinel 80 is scheduled in late 2010 to achieve design-target altitude, speed and duration; and maintain station-keeping capability. Likewise, the instrument payload will demonstrate military utility in imaging and communications applications. While

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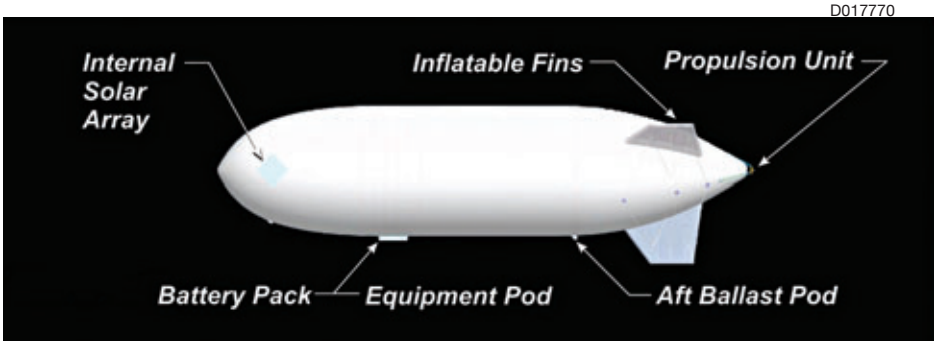

HiSentinel 80 uses internal solar panels beneath its translucent skin to power its propulsion system as well as payloads carried in the equipment pod beneath the craft.

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Earth's curvature is visible behind HiSentinel's lower fuselage and ventral fin in this photograph taken at high altitude from the vehicle's equipment pod.

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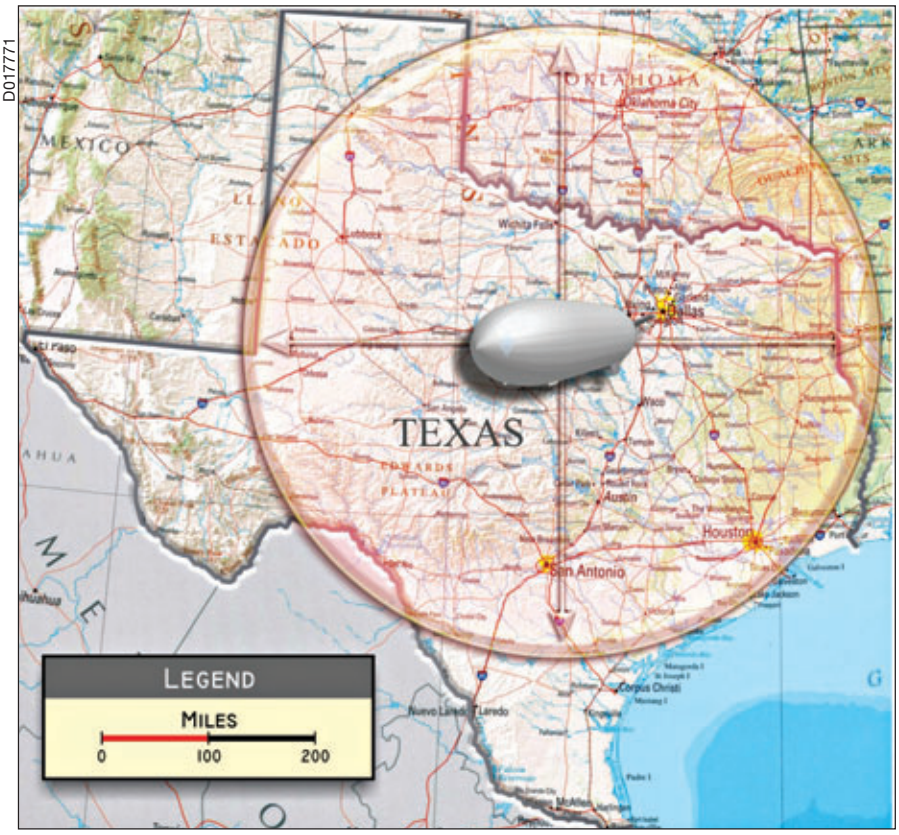

An unobstructed, 600-mile-wide view from HiSentinel's operating altitude means the craft could provide communications or surveillance coverage over large areas.

some balloons previously have ascended higher with payloads (including some humans) suspended beneath in pressurized gondolas, they could not be steered. Only the SwRI engineering team has operated a steerable airship that can fly in the stratosphere.

Observing and evaluating the airships' pressurized structures is complicated because HiSentinel airships are launched in a semi-flaccid condition and don't attain final aerodynamic shape and attitude until they are beyond the reach of most aircraft. Fully inflating this very large and lightweight craft for static testing while tethered outdoors can create hazards including potential structural damage from sudden wind gusts or an accidental puncture of the craft's thin skin.

The SwRI team addressed the static-test problem by inflating the HiSentinel 80 within a large, indoor sports arena: the 65,000-seat Alamodome in downtown San Antonio. The pre-flight inflation was carried out with the facility configured for football, affording the greatest possible obstacle-free length, width and height. Inflated with an air-helium mix and tethered with its tail fin hovering just above the artificial-grass playing surface, HiSentinel 80 stretched from the end zone at one end of the stadium to the opposite 30-yard line, its aerodynamic-shaped envelope easily fitting beneath the steel scaffolding of the stadium roof.

Future applications of HiSentinel

Operational applications of HiSentinel 80 include many of the military communications and ISR missions currently being performed by space-based assets, fixed-wing unmanned aerial vehicles and manned aircraft. Unlike HiSentinel, those other systems are comparatively expensive, require meticulous coordination and cannot remain on-station in a given area of interest continuously for weeks at a time.

For civilian first-responders, HiSentinel can provide information that is more current, accurate and reliable than is typically available via relayed reports from citizens and law enforcement. It also can provide a means of deploying sensors and emergency communications or data-relay equipment to provide information gathering, communications and networking services in a disaster zone, within hours of an event.

Beyond military and homeland security applications, HiSentinel can assist scientists by monitoring levels of high-altitude greenhouse gases and ozone, reporting real-time stratospheric weather, carrying telescopes and sensors aloft and providing wide-area oceanic, coastal and terrestrial monitoring. It could be used to provide continuous observations of sea and glacial ice cover.

In commercial applications, the airship has the potential to provide communications and networking relays, monitor pipelines and power lines, enhance oilfield system telemetry and control and monitor forest, crops and livestock. ❖

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