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Potential Military Use of Airships and Aerostats

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Summary

The Department of Defense (DOD) has a history of using lighter-than-air (LTA) platforms. Aerostats have recently been fielded to protect deployed U.S. troops. Contemporary interest is growing in using airships for numerous missions. This report examines the various concepts being considered and describes the issues for Congress. This report will be updated as events warrant.

Background

Airships and aerostats have been used historically for military surveillance and anti-submarine warfare. Unlike fixed-wing aircraft or helicopters, aerostats and airships are "lighter-than-air (LTA)"; typically using helium to stay aloft. Airships are traditionally manned, and use engines to fly. Aerostats are tethered to the ground, by a cable that also provides power. As many as 32 companies are involved in the design or manufacture of more than 100 commercially available airships and aerostats in Europe, Asia, and North America.[1]

The Navy disbanded its last airship unit in1962, and since then, military use of lighter-than-air platforms has been limited to Air Force custodianship of a dozen aerostats.[2] However, a number of developments have combined to draw increased attention toward LTA platforms. First, U.S. aerospace dominance in military conflicts since 1991 has been overwhelming, making threats to LTA platforms appear to be very low by historical standards. Second, the military's demand for "persistent surveillance," a function for which aerostats appear to be well suited, is growing. Network-centric warfare approaches, increased emphasis on homeland security, and growing force protection demands in urban environments all call for "dominant battlespace awareness."

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[1] *Jane's All the World's Aircraft* (various years), Jane's Information Group Ltd., London.

[2] "Iraqi Conflict Brings Increased Interest in Military Airships," *Sea Power*, The Navy League, July 2003, [http://www.navyleague.org/sea_power/jul_03_01.php].

Third, DOD's growing orientation toward expeditionary operations has spawned studies on using airships as heavy lift vehicles. Fourth, growing budget pressures have encouraged the study of potential solutions to military problems that may reduce both procurement and operations and maintenance spending. LTA platforms may fit into this category. Finally, recent advances in unmanned aerial vehicles suggests that future airships may also be remotely piloted, or fly autonomously.

Current Operations and Programs

Operations. The most well established LTA platform today is the Tethered Aerostat Radar System (TARS) that has been operating since 1980 along the southern U.S. border and in the Caribbean. Currently, TARS' primary mission is surveillance for drug interdiction. Each aerostat can lift 2,200 lbs of sensors to a height of 12,000 feet, and can detect targets out to 230 miles. The aerostat can stay aloft for months.[3]

In response to ongoing threats to U.S. troops deployed to Afghanistan and Iraq, the Army has deployed small aerostats, equipped with ground surveillance sensors, to those countries. The Rapidly Elevated Aerostat Platform (REAP) was jointly developed by the Navy and the Army. This 25-foot long aerostat is much smaller than TARS, and operates at 300 feet above the battlefield. It is designed for rapid deployment and carries daytime and night vision cameras.[4] The Army has also deployed a Rapid Aerostat Initial Development (RAID) system to Afghanistan, Iraq, and Kosovo. This aerostat is approximately twice the size of REAP and operates at approximately 1,000 feet. It also carries a suite of day and night cameras for force protection.[5] The Marine Corps has begun training with RAID, which is a spinoff of a the Army's Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS) program.

JLENS. The Army is leading this joint program. JLENS seeks to use advanced sensor and networking technologies to conduct cruise missile defense. The initial JLENS system fielded (Block 1) will include two separate tethered aerostats. One will elevate a radar to conduct persistent surveillance of the battlespace. The second aerostat will elevate a radar to precisely track the cruise missile and guide an intercepting weapon. JLENS Block 2 will field two un-tethered lighter than air platform, and Block 3 will attempt to field both radars on a single un-tethered lighter than air platform. Approximately $432 million in R&D funds have been appropriated for the JLENS program from FY1996 to FY2006.[6] DOD's FY2007 budget requests $264.5 million for JLENS RDT&E. The JLENS program projects $1.8 billion in spending through FY2011.

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[3] *Tethered Aerostat Radar System*, Fact Sheet, U.S. Air Force, [http://www2.acc.af.mil/library/factsheets/tars.html].

[4] Michael Sirak, "Aerostats to Protect US Troops in Iraq," *Jane's Defence Weekly*, Nov. 19, 2003, "Rapidly Deployed Aerostat Begins Operations in Iraq," *Int. Defense Review*, Mar. 1, 2004.

[5] Emily Hsu, "Aerostat Deployed to Provide Force Protection in Southwest Asia," *Inside the Army*, Apr. 14, 2003.

[6] *Research, Development, Test and Evaluation. Army Appropriation, Budget Activities 6 and 7*. Office of the Secretary of the Army (Financial Management and Comptroller). Years FY1996-FY2006. U.S. House of Representatives. *Making Appropriations for the Department of Defense for the Fiscal Year Ending September 30, 2006*, H.R. 2863 (109-359).

JLENS is seen by some to be an important part of DOD's network-centric warfare approach, because it is the centerpiece of a larger attempt to seamlessly link together numerous sensors *across services* to build a "single integrated air picture" that will enable effective cruise missile defense.

High Altitude Airship. The Missile Defense Agency (MDA) is funding an effort to investigate the feasibility of a high altitude airship (HAA) for homeland defense. Like JLENS, HAA would be unmanned, and provide over-the-horizon surveillance. However, it would not provide fire control-quality tracks, and unlike an aerostat, HAA could move to avoid weather or change radar coverage. The HAA would operate at high altitudes and has been likened to a low flying, and relatively inexpensive satellite. This altitude might enable a small number of airships to surveill the entire United States.[7] The HAA program seeks to demonstrate a prototype by 2010 that could fly for 30 days at a time. Goals are for $50 million airships capable of flying for one year at a time.[8] A total $150.8 million has been provided thus far for HAA. For FY2007, House appropriators (Report 109-504, H.R. 5631) cut $20 million from MDA's $40.6 million HAA request (PE 0603175C), and senate appropriators cut $25 million (Report 109-232, H.R. 5631).

Integrated Sensor is Structure (ISIS).The goal of this Defense Advanced Research Projects Agency's (DARPA) program is to develop a stratospheric airship-based sensor that can remain airborne for years. It is hoped to detect both air and ground targets at long range. The ISIS program will develop technologies to enable large and lightweight radar antennas to be integrated into an airship platform. This approach exploits the platform's size and complies with the platform's weight and power limitations. Major technical challenges include developing ultra-lightweight antennas, antenna calibration technologies, power systems, and airships that support extremely large antennas. House appropriators fully funded ISIS' $16.3 million FY2007 funding request (PE0603287E), while Senate appropriators recommended cancelling the program.

Walrus. Until cancelled by congressional appropriators in FY2006, this DARPA program was developing a hybrid airship capable of transporting up to 1,000 tons across international distances. Unlike traditional, cigar-shaped airships, a hybrid airship is shaped more like an aircraft's wing, to generate lift through aerodynamic forces. Advocates hope that such airships may potentially be capable of carrying a complete Army brigade directly from "the fort to the fight," overcoming logistic choke points and mitigating the effects of limited forward basing. Airships and hybrids may be able to land on water, which could prove valuable to the Navy's sea basing concept.[9] Independently funded hybrid airship programs exist, but with the demise of Walrus, their future is uncertain.[10]

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[7] Jefferson Morris, "Boeing Developing 200-300 Meter Airship for Early Warning Radar," *Aerospace Daily,* Aug. 9, 2002.

[8] Marc Selinger, "High Altitude Airship Demo Planned for Mid-2006," *Aerospace Daily,* Oct. 1, 2003. "Airship ACTD," *Defense Daily,* Apr. 14, 2003.

[9] Chuck Myers, "HULA — A Helium Magic Carpet?" *Proceedings*, June 2003.

[10] Michael Dornheim. "Lockheed Martin's Secretly Built Airship Makes First Flight." *Aviation Week & Space Technology.* February 6, 2006.

Issues for Congress

Generally at issue is whether the operational need for airships and aerostats, and their ability to satisfy this need, outweigh the costs of developing and fielding them. The debate is perhaps most effectively engaged by dividing lighter-than-air platforms into three distinct categories: aerostats, high-altitude airships, heavy lift airships.

Aerostats. The operational need for aerostats and their ability to satisfy this need appears the most mature of the three distinct lighter-than-air platforms. These systems are currently fielded and their capabilities and limitations appear well-documented. The role that they appear most suited for is persistent surveillance. Aerostats' primary advantages over other platforms capable of providing elevated, persistent surveillance (manned aircraft and UAVs) appear to be low life cycle cost and long dwell time.[11]

The primary operational concerns with employing aerostats appear to be vulnerability to weather and enemy ground fire. U.S. and foreign aerostats have been lost to severe weather, as have manned aircraft and UAVs. Aerostats tend not to fail in benign weather, however, while aircraft and UAVs, which are more complex and dynamic systems, suffer accidents caused by factors such as human error and mechanical failure.[12] The vulnerability of aerostats to enemy ground fire is debated. Opponents argue that aerostats are big targets within range of many enemy weapons. Proponents argue that despite their large size, aerostats are survivable because of a low radar cross section and their ability to endure numerous punctures before gradually losing altitude. Low flying aircraft and UAVs are also vulnerable to enemy ground fire.

For land-based applications, technology issues related to surveillance aerostats appear to pertain more to networking and exploiting their sensors than to the balloon itself. One non-traditional aerostat application that may warrant study is replacing, or augmenting, Navy E-2C Hawkeye surveillance aircraft with aerostats. Replacing a carrier air wing's 3-4 E-2Cs with a single or pair of aerostats could potentially improve surveillance by providing 24-hour coverage of the battle group, and could increase the wing's striking power by making room on the carrier for 6-8 more fighter aircraft.

High Altitude Airships (HAA). The operational need and utility of HAAs is less well understood than it is for aerostats. DOD, the Department of Homeland Security (DHS), and other agencies are likely to need considerable time and study to determine exactly what these platforms can do, how they might be exploited, and whether these concepts offer new capabilities. Long-range aerial surveillance, communications relay, Internet services relay, and laser weapon relay for missile defense, and forest fire warning are just some of the roles that HAA advocates would like examined.

The HAA's potential operational environment and long endurance goals present technological challenges for HAAs that appear much greater than those experienced by aerostats. Because the atmosphere is very thin at 70,000 feet, it will require a very large volume of helium to sustain even modest payloads. It is estimated that the HAA ACTD's

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[11] As a point of reference, Congress appropriated $177 million for the eight-site TARS program for FY2000-FY2004. Source: "FY2000-FY2005 TARS Budget," Air Combat Command, USAF.

[12] For more information on military aviation safety, see CRS Report RL31571.

goal of a 500 lb payload will require an airship over 500 feet long and capable of holding over 5 million cubic feet of helium. This airship would be the largest of its kind attempted in the last 60 years.[13] This payload constraint is likely to be a limiting factor for military applications. Some hope, for example, that HAA's could deploy very large sensor arrays that could use low frequency radar to detect small targets, like cruise missiles. However, large radars tend to be heavy. The radar that was being developed for the Air Force's now cancelled E-10A surveillance aircraft, for example, weighs 11,000 lbs.

While producing 500 foot long airships is achievable, their handling characteristics may be challenging. Operating at high altitudes may be an "atmospheric sweet spot" for these large aerostats, but they still must successfully ascend and descend through relatively stormy altitudes. Operating these large airships for months or even years at a time may also prove a technological challenge. Many potential power sources, such as microwaves, are in their infancy, and weight and longevity will be at a premium. Equipment will have to be light, and energy efficient. Further, all systems on an HAA will require uncommon levels of reliability if they are to operate for months or years at a time with no maintenance. This high level of reliability will likely come at increased cost.

A final issue pertains to schedule. MDA hopes to field a prototype by 2006 have already slipped to 2010, confirming the belief of many that this program's schedule is too aggressive.[14] In February 2006, the Air Force Scientific Advisory Board also cast doubt on this schedule when it reported that long-endurance, fixed wing UAVs offer more promise than lighter-than-air vehicles in conducting surveillance from near-space altitudes.[15] The Republic of Korea initiated a HAA program that spans 10 years of research and development. Considering this experience, has DOD established realistic timelines, milestones and budgets to solve technological challenges, mitigate risk, and field a useful HAA platform? Alternatively, has MDA established partnerships or other relationships with researchers in Korea and Japan which have been working on HAA concepts for over six years?

Heavy Lift Airships. Heavy lift airships may raise some questions regarding need and feasibility. Heavy lift airship advocates believe that these platforms can fill a void between sea lift ships that carry very large payloads slowly, and aircraft, which carry smaller loads quickly. Skeptics may argue that there may not be a void to be filled by airships, because the "transport momentum" (payload x speed x annual utilization) of both sealift ships and airlift aircraft are very effective, and these transport media complement each other well.

Another claim by advocates that might invite study, is that heavy lift airships would require much less infrastructure than airlift aircraft. This may be true for conventional Airships, which don't need long runways, and can moor to simple and inexpensive structures. Because *hybrid* airships use aerodynamic lift, however, they will take-off and land much like conventional aircraft. Some estimate that 1,000 ton-class hybrid aircraft

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[13] "RFI Response" to MDA, Airship Management Services Inc., June 28, 2004.

[14] Ibid.

[15] Michael Sirak. "Fixed-wing Unmanned Aircraft Are Air Force's Best Near-Space Option." *Defense Daily*. February 15, 2006.

will require 5,000 foot-long runways.[16] Along with loading, offloading equipment and facilities, these runways appear to constitute infrastructures like those required by conventional aircraft. An attendant issue for hybrid airships is one of safety. What happens when a 1,000 ton semi-rigid airship has an engine failure during takeoff? While the take off speed may not be great, the inertial forces of such a mass would be prodigious. When a conventional aircraft suffers from a mishap, it is towed from the runway and flight operations resume. It appears unlikely that a disabled 1,000 ton airship could be moved quickly, and the airstrip could be blocked indefinitely.

Another issue that must be studied is how compatible 1,000 ton airships would be with DOD's distributed and "just in time" logistical concepts. Delivering a brigade-sized payload directly to a theater of conflict sounds attractive from a conventional wisdom point of view. But, large payloads take longer to consolidate, load, and unload than smaller payloads, and the their delivery must be tightly scheduled. Also, DOD operates on an all weather, day or night, 24/7 timetable. Airships will be more vulnerable to the effects of weather than are conventional aircraft. How severe, or how manageable is this shortcoming? How will an airship capable of lifting 1,000 tons of payload return to the United States once its cargo is offloaded? Would it require a very large ballast or a means of suppressing its buoyancy to be able to fly home?

Vulnerability to attacks is another issue that may warrant study. Airships would fly at an altitude within reach of many surface-to-air weapons. LTA proponents say that airships have a small radar cross section and degrade gracefully if hit. This may be true for the balloon, but a brigade-worth of equipment would have a large radar cross section. Also, while the United States is relatively unchallenged in air-to-air combat, a 1,000 ton airship with a brigade-worth of equipment could constitute a very "high value" target for enemy aircraft. It is likely that DOD would find it prudent to protect these airships with fighters. How many fighters would be required and what would be the costs?

A final issue that pertains to all of the LTA concepts addressed above is cost and budget. The life cycle costs for many unmanned LTA concepts could be notably less than manned aircraft, and satellites, and potentially UAVs. But can DOD find room in its budget for another procurement program? According to some, "a perennial issue in defense policy is whether future defense budgets will be large enough to finance all the weapon acquisition programs that are in the pipeline."[17] This budget pressure, coupled with competition from a well established constituency for conventional aircraft, represent challenges to fielding LTA programs.

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[16] John Wood, "Airships: Good for Business, or Good for Nothing?" Presentation before the 5th International Airship Convention & Exhibition, August 2004, Oxford, England.

[17] CRS Report RL32305, *Authorization and Appropriations for FY2005: Defense*.