

Spy Winds: The Top Secret Story of Lighter-than-Air Reconnaissance Ships and
the Missions They Fly

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AUTHOR NOTE:

This is the full version of the article that was published in the May / June 2025 issue of *Weatherwise* Magazine. This version comprises more historical information and more technical analysis, particularly of Killeen-23 and intelligence collections capable by stratostat ISR ships in general.

On February 1, 2023, passengers on board an airliner flying over Montana were startled by the sight of a mysterious orb-like craft seemingly hovering in the distance. The U.S. Federal Aviation Administration, alerted to object's presence, closed the airspace around the city of Billings, Montana without any public explanation. Billings photographer and videographer Chase Doak, curious about the closure, searched the sky and sighted a tiny, glimmering white dot.

Photographs he shot with a telephoto lens revealed the object to be a spherical balloon with a payload suspended beneath it. The publication of the images in the *Billings Gazette* hours later set off a global frenzy of speculation about the balloon's origin and purpose. Many hypotheses were proffered, from it being hobbyist's project gone awry to extraterrestrial life.

The next day, on February 2, the United States Department of Defense announced the origin and nature of the craft: a Chinese military intelligence, surveillance, and reconnaissance (ISR) balloon, driven along its course in the stratosphere by predominant westerly winds. Various components of the Department of Defense had been tracking the vehicle since mid-January along its aerial voyage from its origin on China's Hainan Island.

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The balloon continued traversing the sky above the conterminous United States in the days after it was first publicly sighted, watched closely by American reconnaissance platforms. High resolution photographs taken from an Air Force U-2 Dragon Lady high-altitude reconnaissance jet provided detail of the craft. Photogrammetric analysis (use of imagery to determine physical dimensions) showed the balloon's diameter to be roughly 150 feet. A straight superstructure, approximately 112 feet in length, was suspended from the underside of the balloon. The superstructure was composed of a rigid metal backbone that held 16 solar arrays, eight on each side. Several antennas and substructures, presumably housing ISR sensors, communication equipment, batteries, and other systems, adorned the middle portion of the superstructure. The U-2 images also showed support lines on the superstructure and guy lines dangling from the balloon. China confirmed their ownership of the craft and stated that its purpose was to collect weather data, but that it had blown off course—a purported cover story not unfamiliar to the United States government.

The cascade of news reports and U.S. government briefings about the balloon painted a limited picture of its function, purpose, and potential threats. While providing some information (and also serving to amaze and frighten), these media reports piqued curiosities and led many to ask: *Why would such a craft be flown in the era of reconnaissance satellites? What technologies and capabilities lay hidden within its superstructure? Was it a new type of spy machine? How many are in operation? And most importantly, what was its mission or missions?* Answers

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from government entities on such matters are typically vague at best due to classification of programs and foreign policy decorum. However, through an analysis of aviation history, a careful review of declassified Cold War-era documents, the study of modern technology of related fields, a review of recent research and developmental programs, and most importantly, a clear understanding of the atmosphere, a comprehensive picture emerges.

The Chinese spy balloon was a type of a broad ranging class of aircraft called a lighter-than-air vehicle, often abbreviated LTA vehicle, LTA aircraft, or just LTA. LTA aircraft are also called aerostats, an anglicization of the French word *aérostat*, derived from *aérostatique*, which loosely translates to “standing in air.” (The term aerostat is commonly used today for a specific type of lighter-than-air vehicle, one that is tethered to the ground and is thus relatively stationary). The largest, most conspicuous aspect of every LTA is its envelope, which holds the vehicle’s lifting gas or cells containing lifting gas. Lifting gas is less dense (“lighter”) than the air in which the LTA operates. This difference in density causes aerostatic, or buoyant, lift, which is the same upward force that causes a submerged cork to rise in water. Aerostatic lift is distinctly different from aerodynamic lift, where the motion of a wing through air generates a difference in pressure, creating an upward force. (Fixed-wing aircraft and rotorcraft like helicopters are classed as “aerodynes” due to their reliance on aerodynamic lift to remain aloft).

A lifting gas may be essentially identical in composition to surrounding air, but heated (“hot air”), and thus less dense, or it may be a special purpose gas. Helium,

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which has a low density and is nonreactive, is the most common special purpose gas used in LTAs today. Hydrogen is the most effective lifting gas due to its extremely low density, but it is no longer used because of its highly combustible nature (the famous *Hindenburg* tragedy occurred due to burning hydrogen). Ammonia and methane have also been tried, but they are also too dangerous due to their combustibility and reactivity.

Engineers have developed many forms of LTAs, all of which fall under two basic categories: airships and balloons. Airships, also called dirigibles (from the French *diriger*, meaning “to direct”) are LTAs comprising self-propulsion and self-steering mechanisms. Balloons are LTAs without the ability to self-propel and cannot be directly steered (some balloons can be indirectly navigated by increasing or decreasing altitude into known predominant winds).

Early History of Lighter-than-Air Vehicles

The first known lighter-than-air-vehicles took to the sky in China in the 3rd century during the early Three Kingdoms period. Developed in concert with rudimentary meteorology, these craft were small hot-air balloons traditionally called “Khood Fay” and today often called “sky lanterns.” The design, created by Chinese polymath Zhuge Liang, used silk or oil-based rice paper for an envelope that was supported by a bamboo frame. A small candle or oil lamp, suspended within the opening of the envelope, provided a continuous supply of heat to keep the craft aloft.

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Zhuge Liang, also known by his courtesy name Zhuge Kongming, is historically renowned as a military strategist, military tactician, engineer, inventor, and observer of the natural environment, including observations of weather and the atmosphere. Authors lionized him as having the ability to “summon” and control winds during battles. More detailed analysis of his combat leadership reveals that his “summoning” successes were his actions based on his weather forecasting acumen. His forecasts gave him the knowledge to precisely time battlefield movements to gain tactical advantage over his adversaries.

Kongming developed Khoom Fay balloons as a form of military communication, deploying them in winds he observed and forecasted. The balloons physically delivered written messages and communicated visual cues by their presence and through the glow of their flame-illuminated envelopes. In addition to being the first ever known LTAs, Khoom Fay balloons were the first weather balloons, as they visually indicated the speeds and directions of winds aloft. This helped refine the ways in which the balloons were deployed to achieve desired altitude and distance.

The use of Khoom Fay balloons for military communication proliferated throughout China for many years (and the basic design endures to this day, used for nighttime celebrations). Little is known about the migration of the concept to other regions, however. Although the design was technologically capable of lifting cargo, including a human if constructed to large enough dimensions, no known record exists that documents Kongming’s balloons being used for any purpose other than simple communication. Despite this, the Khoom Fay balloons provide

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an intriguing and little recognized series of precedents of fundamental utility relevant to the Chinese spy balloon story: Kongming developed the balloons specifically for military use; their operation required a basic understanding of the mechanics of the sky; and their use expanded knowledge of the atmosphere that engendered the refinement of how the balloons were employed.

The First Lighter-than-Air ISR Ships

More than a thousand years passed until the next significant events took place in the history of lighter-than-air vehicle development. In 1709, Portuguese Jesuit priest and inventor Bartolomeu de Gusmão demonstrated a small hot-air balloon to King John V of Portugal in Casa da Índia, Lisbon. The craft, made of paper, successfully rose into the air, but no known historical records document any further successes. Decades later, in the early 1780s, inventor Joseph-Michel Montgolfier of France became intrigued by how embers rose above fire. He mused that the same force could be harnessed to lift troops into fortresses for military raids. He built and successfully tested a small hot-air balloon made of cloth, mistakenly believing that a special gas, which he called ‘Montgolfier Gas,’ was the lifting agent, not heated air.

Joseph-Michel then constructed a larger balloon with his brother, Jacques-Étienne. In December of 1782, the two filled the balloon with heated air by burning hay and wool. The balloon rose off the ground and winds carried it roughly one mile before the heated air cooled and it landed. Six months later, on June 4, 1783, the duo publicly demonstrated a more advanced balloon at the town of Annonay. The craft

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dazzled spectators as it rose to an altitude estimated to be as high as 6,500 feet above the ground. It remained aloft for roughly ten minutes, during which time wind blew it more than a mile to its landing point. The Montgolfier brothers then launched their next LTA, *Aérostat Réveillon*, on September 19, 1783 at the Palace of Versailles. The hot-air balloon held a basket beneath it that carried the first living beings in history to fly on an aircraft: a duck, a rooster, and a sheep named Montauciel (“rise to heaven”). The trio, history’s first “aeronauts” (passengers in a lighter-than-air craft), became instant celebrities. This success was followed the next month in Paris by the first flight of a balloon with human passengers, one of the greatest feats in the history of aviation and in technology in general.

1783 was also the year of firsts for hydrogen LTAs. French brothers Anne-Jean and Nicolas-Louis Robert flew the first hydrogen balloon in Paris on August 27. The brothers then built a larger craft that became the first manned hydrogen balloon. Nicholas-Luis and French scientist Jacques Charles launched it from Paris and flew for more than two hours on December 1. The two took readings from a thermometer and a barometer they carried, making this flight the first time in history that meteorological readings were taken from a manned aircraft.

Just over ten years later, on April 2, 1794, the French established the world’s first military aviation unit, La Compagnie d’aérostiers, the French Aerostatic Corps. The unit was organized, trained, and equipped with manned hydrogen balloons primarily for a mission type that has endured for LTAs to the present: intelligence, surveillance, and reconnaissance (ISR). The Aerostatic Corps could also perform

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communication duties by relaying signals between ground troop units and drop leaflets for propaganda purposes.

The Corps undertook its first ISR missions in early June of 1794 during the French Revolutionary Wars. The most notable of these was the 9-hour flight of the balloon *L'Entreprenant* during the June 26, 1794 Battle of Fleurus in the Austrian Netherlands. The observers on board made continuous observations of the battle and relayed messages to troops below about enemy movements using handwritten notes. The information proved crucial to the French, who ultimately prevailed in the fighting. The Aerostatic Corps also performed some limited communications relay functions, and their presence above the battlefield may have had psychological effects on the enemy.

While balloons proved successful in their military operations, these missions also reinforced that weather and the whims of the atmosphere dictate how they can be used, to what extent they can be used, and if they can be deployed at all. Operating *L'Entreprenant* during the Battle of Fleurus required a large contingent of ground handlers with tethering ropes to maintain the craft at a proper position and altitude due to winds. Military ISR balloons, in addition to providing new capabilities, also introduced a new reason to keep an eye on the sky and to build a greater understanding of meteorology.

The importance of understanding and forecasting atmospheric conditions for LTA use in combat was dramatically demonstrated in 1849 during the Austrian empire's

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blockade and siege of Venice. Austrian forces attempted to drop hundreds of bombs onto Venice via paper hot-air balloons fitted with fused releases. The Austrians launched the LTA marauders from land and a ship at sea, the paddle steamer *Vulcano* (the first offensive use of naval airpower in history). Winds aloft did not behave as forecast, however. Only one struck Venice, and some drifted back over the *Vulcano* as well as terrestrial launch sites.

The 1850s and 1860s witnessed great strides in the capabilities of lighter-than-air vehicles, and LTAs used for military ISR in particular. These advances were most notable in the 1860s, propelled by the Union Army due to the strategic imperative of the American Civil War. American inventor, meteorologist, and aeronaut Thaddeus S.C. Lowe stood at the forefront of these innovations. A late childhood fascination with lighter-than-air balloons led Lowe to pursue ballooning as a career. He constructed his first from specially coated silk that he filled with coke oven gas (50 to 60 percent of which is composed of hydrogen gas) and used it to give flights to paying customers. He then crafted a second, larger balloon, the *Enterprise*. In April of 1861, he flew the *Enterprise* on a 900-mile journey where he climbed to an altitude of 20,000 feet above sea level. Invited to Washington, D.C. for a demonstration for President Abraham Lincoln, Lowe made a tethered flight of the *Enterprise* that soared 500 feet above the White House (launching from the location of today's Smithsonian National Air and Space Museum). He carried a telegraph (which had just been invented in 1844) and made the first aerial telegraph communication. Transmitted to President Lincoln in the White House

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below, Lowe described the incredible vantage from his aerie and the wide-ranging benefits it would provide troops during combat.

Lincoln appointed Lowe the chief aeronaut of the planned Union Army Balloon Corps, marking the dawn of American military aerial ISR and modern aerial ISR in general. Once established, Lowe and the Balloon Corps undertook aerial surveillance of Confederate troops, aerial mapping, and established the practice of aerial forward observation. With aerial forward observation, aeronauts surveilled targets of artillery fire and provided ground personnel, who often could not see targets, with aiming adjustment information to achieve pinpoint accuracy.

Lowe combined LTA operation with several other technologies to synergize aerial ISR capabilities, including the telegraph for instant communication with ground forces. He also experimented with aerial photography (the first aerial photograph in the United States had been taken in October of 1860 from a balloon over Boston). The photographic process at the time, however, proved too cumbersome and time consuming to be of value during combat, so verbal descriptions and hand drawings were used (unfortunately, no known aerial images from the American Civil War remain in existence). Lowe also pioneered manned LTA operation from ships. On November 11, 1861, Lowe lifted into the sky in a Union Army ISR balloon from the USS *George Washington Parke Custis*, the first purpose-crafted aircraft carrier in history (it was repurposed from a coal barge). Despite the successes, the aeronauts of the Union Army Balloon Corps were frequently reminded that balloon operation could be shut down at a moment's notice by

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unforeseen atmospheric conditions. Lowe's first purpose-built military balloon, *Eagle*, was snatched away by an unexpected gust of wind, suspending all balloon activities temporarily.

Dawn of the Airship

The concept of freely roaming the sky, untethered to ground handlers and out of the clutches of unfavorable winds, inspired the creation of the airship. Airships, unlike balloons, have onboard thrust and steering mechanisms that allow pilots to fly to points in the sky at will. French inventor Jean-Pierre Blanchard made the first rudimentary airship in history by attaching wing-like oars and a tiller to a hydrogen balloon. Launching from Paris on March 2, 1784, his system proved inadequate as winds carried him far off his intended course. French inventor Henri Giffard flew the first functional airship in 1852, the Giffard Dirigible. Filled with hydrogen, the airship comprised a gondola with a rudder and a steam engine that turned a large propeller. Giffard launched the airship from Paris and flew it roughly 17 miles, demonstrating its ability to steer along the route. The engine, which weighed more than 400 pounds yet generated just three horsepower, was not powerful enough to overcome a headwind for a return journey. Functional internal combustion engines, which are far more powerful pound-per-pound than steam engines, had not yet been developed. Airships simply weren't practical in the mid-19th century based on powerplant technology alone. They couldn't overcome much more than the mildest of winds and could only carry small payloads.

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The decades that followed the flight of the Giffard Dirigible saw remarkable strides in both internal combustion engine technology and innovations of airships themselves. German military officer and inventor Count Ferdinand von Zeppelin pioneered the most notable airship designs. He had served as an observer with the Union Army in the American Civil War and became intrigued by the balloons used for observation and other ISR roles by Thaddeus Lowe. In addition to military applications, he pondered using LTAs for mail delivery and passenger service. This would require large payload capability, powerful engines, and sleek envelope designs to mitigate aerodynamic drag and overcome winds.

Von Zeppelin and his team pioneered the concept of the rigid airship, where the envelope of the dirigible is supported by an internal frame. This allowed them to build envelopes that were hundreds of feet in length, could hold hundreds of thousands of cubic feet of hydrogen, and hence lift tens of thousands of pounds of payload. Von Zeppelin's envelopes were cylindrical in shape and came to a point at each end. This minimized drag, and due to the internal structure, the envelope would maintain its shape even in moderate winds.

The basic design of von Zeppelin's airships had two gondolas suspended from the large envelope. In addition to aircrew, passengers, or cargo, each of these gondolas housed one or more internal combustion engines that turned large propellers. The first of von Zeppelin's airships, the LZ-1, took its maiden flight on July 2, 1900. Several designs followed, each incrementally faster, larger, and more powerful. Von Zeppelin founded the company Luftschiffbau Zeppelin (Zeppelin Airship

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Construction) in 1908 to produce dirigibles for commercial and military purposes. He then founded DELAG (Deutsche Luftschiffahrts-Aktiengesellschaft – “German Airship Travel Corporation”) in 1909, the world’s first airline. Von Zeppelin’s airships were so successful that the name “Zeppelin” became synonymous with “airship” and “dirigible,” a convention that continues to this day.

World War I and the Zenith of military LTAs:

The zenith of lighter-than-air vehicle use occurred during World War I. The era witnessed rapid advances in all forms of technology used in warfare, including submarines, airplanes, and all types of LTAs. Germany’s recently introduced rigid airships by Luftschiffbau Zeppelin and the lesser-known company Luftschiffbau Schütte-Lanz flew bombing raids due to their ability to carry large payloads and fly high above anti-aircraft fire. These missions caused relatively little physical damage, but the massive airships themselves instilled fear among residents of cities over which they flew, notably London.

Intelligence, surveillance, and reconnaissance, while not as dramatic as bombing operations, ranked as the premier use of lighter-than-air vehicles during the war. Both the Allies and the Central Powers used several types of LTAs for surveillance of enemy movements, to identify the presence and location of submarines, and for artillery observation. This included all three types of airships developed to that point in time: rigid, semi-rigid (an airship with a keel, but no internal structure), and non-rigid (more commonly called “blimps” and technically termed “pressure airships” as internal pressure within the envelope maintains external form).

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Balloons used during World War I included “free” and “kite” types. Free balloons were untethered balloons used for ISR and for dropping propaganda leaflets. Kite balloons, also called “captive” balloons, were tethered to the ground or to ships at sea and were more numerous than any other type of LTA used during the war. Employed primarily for ISR, kite balloons comprised features like fins to maintain stability and gain altitude in wind.

Despite many successes, military lighter-than-air vehicles began their descent toward obsolescence as World War I progressed. Airplanes, unwieldy and slow upon their debut in the early 1900s, had quickly advanced in the following years. Manufacturers created more capable airplanes with each passing month during the height of the war. Airplanes were able to perform ISR missions throughout a much broader range of atmospheric conditions than LTAs and get into the air and over targets much more quickly. Airplanes could also easily shoot down balloons and airships, as their large forms made them easy prey.

Weather Balloons, the Discovery of the Stratosphere, and Stratostats

Far less prominent than the ISR balloons and great airships that emerged in the years just prior to and during World War I, purpose-built weather balloons made their debut in the late 1800s. At the time, meteorologists used kites as air vehicles to take measurements of key criteria of vertical profiles of the atmosphere. Called soundings (a term adapted from maritime use meaning to measure the depth of water), this information included temperature, relative humidity, and pressure. A

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device suspended by the kite called a meteorograph, which held a thermometer, a barometer, and a hygrometer, recorded the data on a clock-synchronized chart. While weather kites proved effective and their use proliferated throughout the United States and Europe, their operation was limited to roughly 10,000 feet above sea level.

The first weather balloons, which used small envelopes filled with hydrogen that carried meteorographs, could ascend much higher. Two of the pioneers of weather balloon use, Léon Teisserenc de Bort of France and Richard Assmann of Germany, each discovered an intriguing meteorological trend at altitudes above roughly 33,000 feet: temperatures increased with height, opposite of that in the troposphere, the lowest portion of the atmosphere. Both announced the discovery in the spring of 1902, with Léon Teisserenc de Bort naming the layer the “stratosphere,” as it comprises stratified layers of air. Research in subsequent years would provide troves of information about the stratosphere, knowledge with important ramifications for future lighter-than-air craft.

The lower boundary of the stratosphere ranges from 21,000 feet above sea level in polar regions to 65,000 feet at the equator, and its upper limit lies at 165,000 feet above the planet’s surface. The properties of the stratosphere are starkly different than those of the troposphere. The troposphere comprises roughly 80% of the atmosphere’s gases, including 99% of its water vapor. The stratosphere, which accounts for 19% of atmospheric mass, contains virtually no water vapor, so no clouds form (apart from rare, thin, wintertime polar stratospheric clouds, also

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called nacreous clouds). While temperature decreases with altitude in the troposphere (in general), it increases with altitude in the stratosphere (due the absorption of ultraviolet radiation by ozone molecules). This temperature profile inhibits convection, keeping the air of the stratosphere laminar and almost completely free of turbulence. While almost all the planet's weather occurs in the troposphere, the stratosphere's only weather events, outside of wind, occur when the tops of powerful cumulonimbus clouds push into its lower levels.

The stratosphere remained the exclusive domain of weather balloons throughout World War I and the 1920s. This changed in the 1930s, during the height of what aviation historians call the "Golden Age of Flight," a period of tremendous strides in aerospace technology. On May 27, 1931, Swiss physicist Auguste Piccard and his assistant Charles Kipfer, enclosed in an airtight metal gondola, ascended to the altitude of 51,775 feet above sea level, deep in the stratosphere. The envelope of the balloon was constructed of rubber-impregnated cotton fabric, weighed 1,500 pounds, and had a maximum volume of 500,000 cubic feet.

The feat marked the first intentional journey into the stratosphere by humans (Englishmen James Glaisher and Henry Tracey, flying in a hydrogen balloon, unintendedly entered the lower stratosphere in 1862, but were rendered unconscious due to hypoxia). Piccard's feat, undertaken to study the chemistry of the stratosphere and cosmic rays, set off a "pre-Space Race," with aeronauts from the United States, the Soviet Union, and other countries vying for title of the highest stratospheric balloon flight. The attempts, lionized by media throughout the

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world, introduced a new term to the public, stratostat, or stratospheric lighter-than-air vehicle.

In 1934, the first woman in history reached the stratosphere. Jeanette Piccard and her husband Jean Piccard (twin brother of Auguste), ascended to 57,552 feet above sea level over Lake Erie on October 23 in a stratostat. The two continued their work on stratostats after the flight, inventing the first plastic film stratostat envelopes, which were much lighter than the rubberized cotton material used for previous flights. The technology was vital to the continued pursuit of higher altitudes, as envelopes needed to be as light as possible yet hold as great a volume of lifting gas as possible. In 1936, working at the University of Minnesota's aeronautical engineering department, Jean Piccard developed the *Pleiades*, the first plastic film LTA. It used a cluster of 92 balloons that suspended a metal gondola and flew to 11,000 feet on a test flight. The plastic film envelope concept would eventually prove to be one of the most enduringly important engineering feats in the history of lighter-than-air aviation.

Military LTAs in World War II

During the Second World War, militaries of several nations used LTAs, although far less extensively as during World War I. This included Soviet balloons for artillery observation and the U.S. Navy using balloons and airships for anti-submarine warfare and general reconnaissance. The British used kite balloons as

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defensive “barrage balloons” to form physical barriers around cities against German aerial attack. Some of these broke free during windstorms and their mooring cables short-circuited power lines.

The British military, inspired by the damage inflicted by the wayward LTAs, unleashed Operation Outward, using winds as engines of offense. They armed nearly 100,000 surplus hydrogen-filled weather balloons, some with payloads of incendiary bombs and some with long cables. They released the balloons into favorable winds to be carried to Germany and German-occupied territories to damage electricity infrastructure and ignite fires. Operation Outward inflicted widespread, but limited damage. The Japanese also used winds to drive LTAs for offensive purposes during World War II. They unleashed “Fu-Go” balloon bombs from Japan into predominant westerly winds to be carried to the United States. Thousands were dispatched, but only one inflicted any fatalities—six people in Oregon who happened upon one on the ground.

The U.S. Navy continued limited flights of ISR blimps after World War II. Some of these were used to locate submarines and some were positioned to detect potential incoming attacks, a mission called defense early warning. Able to loiter over a region for days (an important operational trait called “persistence”), Navy blimps carried some of the most sophisticated reconnaissance systems created to that point, including advanced radar.

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With the last of the U.S. Navy's ISR blimps retiring in the 1960s, military lighter-than-air vehicles looked to have reached a twilight. Far from the public's eye, however, behind a veil of disguise, several top secret programs took flight shortly after the close of World War II.

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The Cold War, Top Secret Meteorology, and the Rise Stratostat Spy Ships:

From Khoom Fay balloons to the most advanced U.S. Navy blimps used just after World War II, lighter-than-air vehicles demonstrated that their operation is entirely subject to the sky's whims. Airplanes (and then helicopters) proved to be far better suited for virtually all airborne missions as they can operate in adverse weather, fly faster, and are nimbler. With the opening of the Cold War, however, applications emerged that were ideally and exclusively suited for a type of LTA that at that point had never been used for military purposes, the stratostat.

In 1945, at the end of World War II, Jean Piccard approached the United States Navy's Office of Naval Research with an idea: build a manned stratostat using an array of thin-film balloons for high-altitude scientific research. The proposed craft, called *Pleiades II*, was to use a cluster of balloons to carry a 2-person, airtight, spherical capsule to 100,000 feet in the stratosphere. The Navy agreed to pursue the initiative, renaming it Project Helios. Piccard enlisted the help of an engineer named Otto Winzen, who had previously expressed interest in Piccard's thin-film stratostat work.

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Piccard and Winzen sought the best material for the new envelope, basing their work on Piccard's earlier investigations from the 1930s. Due to the low pressure at extreme stratospheric altitudes, envelopes need to be much larger to hold a much greater volume of lifting gas than those operating at lower stratospheric altitudes. The material Piccard and Winzen sought needed to be lighter than any previously used for balloon envelopes, yet strong enough for the rigors of extreme altitude, long-endurance missions. It needed to maintain a fully inflated shape, resist tearing, and be able to support the weight of a gondola. They settled on ultra-thin films of polyethylene, a plastic first synthesized in Germany in the late 1890s and used as cable insulation by the British in World War II.

The Navy contract for Project Helios was won by General Mills, which, although primarily a cereal maker, had operated a division during World War II that made torpedoes and other warfighting implements for the Navy. In 1946, General Mills established a new subsidiary for Project Helios, the Aeronautical Research Division. The company hired Winzen as chief engineer and then began developing strong, high-volume stratostat envelopes intended to reach 100,000-foot altitudes. One of Winzen's most notable innovations was a heat-sealing method that formed a suspension system built into the thin-film envelope. This intrinsic reinforcement made it capable of withstanding both tension from internal pressure as well as the weight of a suspended gondola.

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Winzen and engineers at the Aeronautical Research Division created the most advanced balloon envelope to that point in history. Made of polyethylene film that was just 1/1000 of an inch thick, it could hold up to 30,000 cubic feet of lifting gas. Unfortunately, the Navy cancelled the program before launching a single stratostat. Winzen's creation would not be shelved, however. It immediately went into service for another American project, a recently begun U.S. Army initiative called Project Mogul.

Following World War II, the highest priority of American Intelligence agencies was the assessment of Soviet nuclear weapons development progress. With testing facilities located deep within the Soviet landmass, Americans sought platforms with long-distance detection capability. Begun in 1947 at the opening of the Cold War, Project Mogul used acoustic sensors flown above various locations in the United States on high-altitude balloons. Unable to hide the launch of the balloons, the Army used an ongoing civilian high-altitude meteorological research project as a cover. This was the first use of a practice of Cold War deception that the U.S. government would repeat numerous times during subsequent stratostat projects. Despite high hopes, the program yielded few substantive results.

The cancellation of Project Helios did not mark the end of the U.S. Navy's interest in stratostats. Mere weeks after ending Helios, the Office of Naval Research inaugurated the highly ambitious Project Skyhook, with Otto Winzen as technical lead. The goal of the initiative was to develop advanced unmanned stratostats to operate for extended periods at altitudes up to 100,000 feet above sea level. The

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first of the Skyhook balloons lifted off on September 25, 1947 from St. Cloud, Minnesota. Its envelope was a Winzen thin-film, polyethylene type with a capacity of 100,000 cubic feet that used hydrogen as a lifting gas (it could also use helium). Fully loaded, the hydrogen filled a small portion of the upper envelope while at ground level. It formed a bubble at the top of the balloon, with the bulk of the envelope draped below it. As it rose, the hydrogen expanded, stretching the envelope into a spherical shape with a diameter of 100 feet. It carried a 70-pound payload and climbed to an altitude of more than 100,000 feet, traversing 140 miles of sky before returning to the ground near Eau Claire, Wisconsin. The flight, which the military publicly disclosed, was one of the most successful in the history of lighter-than-air vehicles, leading the Navy to expand the project.

According to an article published in the August 1954 issue of *Weatherwise* about long-distance, high-altitude balloon meteorological systems, stratostats of Project Skyhook were to travel "...into the upper reaches of the stratosphere to gather scientific data for a variety of research programs." The first flight carried a suite of meteorological instruments and a cosmic ray detector as part of its 70-pound payload. However, like Project Mogul, Project Skyhook had an undisclosed primary goal.

Top secret documents, declassified by the United States Central Intelligence Agency in 2009 and 2011, describe the purpose of some of the "variety of research programs" noted in the *Weatherwise* article: to study the stratosphere's conditions, notably winds, to determine the viability of using stratostats to overfly the Soviet

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Union and other Eastern Bloc countries for ISR purposes. The balloons of Project Skyhook were covert, unmanned, stratospheric explorers launched to gather data for the development of long-range, extreme-altitude spy missions. The September 25, 1947 flight marked the beginning of the top secret side of stratospheric meteorology.

Material and construction techniques used for lightweight, high-volume envelopes were just two of the technologies critical for the stratostats of Project Skyhook to undertake their intended missions. The myriad components, notably electronic circuits, used in the balloon payloads had become more reliable, required lower power, and had become smaller in size due to advancements over the previous decades. This allowed radio tracking capabilities, innovative telemetry, greater measurement precision, and increased endurance for long-distance, high-altitude missions. The August 1954 *Weatherwise* article that discussed Project Skyhook, written by Albert D. Anderson and Henry J. Mastenbrook of the Naval Research Laboratory, was titled “The Transosonde.” The article described the purpose and operation of the transosonde, or trans-oceanic-sonde: “The immediate object was the transmission of meteorological information by constant level balloons over broad expanses of ocean where data collecting has been prohibitively expensive.” While the writers discussed non-classified projects, the same type of technology was used in the craft that were setting the stage for spy missions. Payloads of these state-of-the-art stratostats were similar in concept to the original meteorographs carried by the first weather balloons (and previously by weather kites), but much more sophisticated, precise, and robust. This allowed operators to build an

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understanding of the stratosphere and its conditions that was impossible just a few years earlier.

The declassified CIA documents contain troves of information about stratospheric conditions pertaining to high-altitude ISR balloon operations. One of these documents, produced by Project RAND for the U.S. Air Force, was titled “Expected cost and payoff of a high intensity balloon pioneer reconnaissance campaign over the U.S.S.R.” Dated December 10, 1953 (and declassified on September 28, 2009), the top secret report explains initial meteorological analyses completed in November of 1950 for proposed stratostat missions. These planned operations were to carry specialized cameras and other intelligence data collections equipment.

The report discussed cloud cover considerations for camera use, altitudes, and winds. “One of the basic constraints on a balloon pioneer reconnaissance system is the need for using it during a season when the winds are most favorable,” the report explained, then listed the months of November through February as prime candidates. Further information in the documents revealed that the conditions of the stratosphere were far more favorable, consistent, and forecastable than those of the troposphere.

The initial Skyhook missions demonstrated that the stratosphere was the most welcome part of the atmosphere for lighter-than-air vehicles, but of only a highly specialized type. It is an ally, an operational “home” for LTAs due to its

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predictable, consistent conditions. This starkly contrasts with the relatively volatile nature of the troposphere, as evidenced by numerous events in the history of LTAs where unpredicted changes in conditions quickly ended operations, sometimes with deadly outcomes.

After reviewing the meteorological information gathered by the early Project Skyhook flights, the U.S. military began a series of clandestine stratostat projects. These were intended to overfly the Soviet Union and other Eastern Bloc countries, including China, to gather information on their military capabilities and force positions. The first, initiated by the United States Air Force, was a systems development program designated MX-1594, AKA Project Gopher. It was spearheaded by Otto Winzen's new company, Winzen Research.

The stratostat system developed under Project Gopher, called WS-119L (Winzen System-119L), comprised a thin-film envelope, an altitude regulation system, and a payload bay. The bay was designed to carry two cameras, both of which were activated by a photovoltaic light sensor to save film during periods of darkness. Film exposure was controlled by intervalometers that released camera shutters at predefined rates. The WS-119L payload bay had a radio telemetry system for tracking and a system to release it for a parachute descent that would be activated by a timer or by remote control. Once released, the descending payload would be snared mid-air by a modified Air Force C-119F Flying Boxcar cargo airplane over friendly territory. Prior to launching the balloons, the United States tested them

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over the United States as part of Project Moby Dick, which, like Project Mogul, used a cover story of meteorological research.

Between January 10 and February 6, 1956, the American military covertly launched 448 WS-119L balloons into predominant westerly winds from Germany, Norway, Scotland, and Turkey as part of Project 119L (also called Project Genetrix). Although capable of flying at 100,000 feet, President Eisenhower mandated that the stratospheric armada remain between 49,000 and 55,000 feet for the five- to seven-day journey. The top secret U-2 Dragon Lady high-altitude reconnaissance aircraft was soon to enter operations, and the president did not want to encourage the Soviets to develop systems that could down aircraft flying higher than 55,000 feet.

Only 34 of the balloons managed to complete their missions with recoverable payloads. Many malfunctioned and crashed, and the Soviets downed several with interceptors. The Soviet Union staunchly protested the invasion by American “aerial spheres” with “automatic photographic cameras.” The U.S. government proclaimed that the balloons were dispatched to study the atmosphere—but blew off course. “...the presence of cameras could be explained as a project to study cloud formations...” stated one top secret document about the development of Project 119L. Relations reached a breaking point when the Soviets displayed recovered payload bays with cameras, but no meteorological equipment.

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The few recovered canisters of exposed film produced no useful imagery intelligence. The project did yield critically valuable information, however. NATO radars had tracked the WS-119L balloons as they drifted over the skies of the Soviet Union and other Eastern Bloc countries. The recorded pathways provided detailed information about the winds over these areas. While the original Skyhook balloons revealed general information about the conditions of the stratosphere, the radar data of the WS-119L balloons provided specifics of the stratosphere over target areas. The most useful intelligence data gleaned by Project 119L were not images taken by the balloons, but the details of the stratospheric “spy winds” that propelled them. This data was processed into valuable information for future ISR flights—by the U-2.

In January of 1958, a year after the mass balloon flight of Project 119L, the U.S. Air Force initiated Project 461L. The program used larger stratostats that could stay aloft for up to 30 days per flight. They carried a new, state-of-the-art camera, a HYAC-I (high-acuity) panoramic camera. It featured a 120-degree field of view and was constructed of fiberglass to reduce radar signature, making the balloon systems partially “stealth.” Due to the Soviet Union’s rapid development of nuclear weapons and intercontinental ballistic missiles at the time, Eisenhower approved the mission, despite the failure of Project 119L. The stratostats were launched in the Pacific Ocean from the deck of the U.S. Navy ship *USS Windham Bay* in July of 1958. Like previous missions, the military provided a cover story that they were being flown for meteorological research.

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The stratostats began their journey westward, powered by predicted seasonal easterly winds. During their journeys, they presumably photographed large swaths of the Soviet Union in high resolution. Both timing and timers undid the mission, however. The stratostats were launched into summertime air currents when these winds were beginning to weaken in strength. The onboard timers, not programmed to take the reduced wind speeds into account, released the payloads while over Poland. The HYAC cameras (derivatives of which would be used in the first U.S. Corona photoreconnaissance satellites) fell into Soviet hands. An irate Eisenhower cancelled any further such missions.

The stratostat spy missions yielded no useful imagery and were strategically counterproductive due to the negative diplomatic fallout and embarrassment of their outcomes—advanced camera systems falling from the sky into enemy hands. From an innovation standpoint, however, the technology developed for these systems was some of the most important and successful in history. Most notably, the operations delivered troves of knowledge about the stratosphere, although much of it remained classified for decades.

The utility of the thin-film envelopes during the Cold War was not limited to covert ISR gathering operations. The U.S. government employed them for several other purposes, including high altitude research, weapons testing, and astronomy. One project, dubbed “Operation Stratomouse,” lofted live mice and other living organisms into the stratosphere in airtight spheres for physiological research. Project Manhigh lifted researchers to the edge of space in sealed capsules. A 1957

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Manhigh flight, using a Winzen envelope with a volume of 3 million cubic feet, carried a researcher to an altitude of 101,516 feet above sea level. Project Strato-Lab, which performed several tests related to the nascent American space program, carried a researcher to a record setting altitude of 113,740 feet above sea level on May 4, 1961. Project Stratoscope carried telescopes for unmanned astronomy purposes. “Yucca” was the code name of the only balloon-borne nuclear weapon test in history. A component of Operation Hardtack, a stratostat carried a nuclear warhead to 85,000 feet over the South Pacific Ocean on April 28, 1958 where it was detonated by remote control.

While not as dramatic as nuclear testing, record setting altitudes, and high-flying mice, numerous meteorological research missions like those documented in the August, 1954 *Weatherwise* article were enabled by the technology developed for ISR missions. Ironically, the greatest dividend of stratostat development was paid to the type of work that was initially used as a cover for these innovations: meteorological research.

Modern Lighter-than-Air ISR Systems – Rebirth of the Stratostat Concept:

The disasters of Projects 119L and 461L occurred during the period when both reconnaissance satellites and high-flying jet platforms like the U-2 and SR-71 debuted. Few resources were applied to either stratostats or lower-flying balloons and airships in the following decades for intelligence, surveillance, and reconnaissance applications. Notable exceptions include the Tethered Aerostat Radar System (TARS), the Persistent Threat Detection System (PTDS), and the

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Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS). Each of these systems are low-altitude, tethered helium balloons that incorporate fins on their envelopes for aerodynamic stability. Each features a suite of powerful surveillance tools, which can include downward-looking radar, infrared scanners, video cameras, and other sensors. Resembling the “kite balloons” of World War I, they have been used for highly specialized roles like border security and in combat zones in Iraq and Afghanistan.

As with previous use of low-altitude LTAs through the centuries, weather can prove unpredictable, with disastrous results. In August of 2011, a line of thunderstorms tore a TARS balloon from its mooring in Puerto Rico and destroyed it. In October of 2015, strong winds ripped a JLENS aerostat from its anchor at a Maryland testing site and dragged it into Pennsylvania, causing major power outages when its cable crossed high voltage transmission lines.

Satellites, manned aircraft, and unmanned aerial vehicles may seem to have rendered stratostats unnecessary for ISR data collection purposes in the decades since Projects 119L and 461L. Multiple research initiatives in the past few decades, however, reveal that stratostats are advantageous for several ISR applications for two key reasons. Stratostats can “persist” over an area for weeks or even months, and they operate much closer to the planet’s surface than satellites. They are also far less expensive to develop, deploy, and sustain.

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A 2005 NASA paper, “High-Altitude, Long-Endurance Airships for Coastal Surveillance,” explains the feasibility of using stratospheric airships for months-long, continuous surveillance over specific locations. Manned and unmanned airplanes, the paper noted, cannot remain over an area for more than a few hours due to refueling and crew needs. Satellites can offer only limited persistent observation of a specific location due to their orbits. Stratospheric LTAs can remain aloft for months, using solar power to sustain their systems. They can remain over a specific location by climbing or descending in altitude based on known wind patterns at different elevations within the stratosphere.

A United States Air Force paper published in 2005, “Lowering the High Ground: Using Near-Space Vehicles for Persistent ISR,” describes how high-altitude balloons and airships can fulfill long-duration, persistent ISR missions that no other platform can undertake. These include precision monitoring of targets using electronic systems that need to remain in place for days or even weeks at a time. The paper highlights a fundamental deficiency in satellite systems: their orbital paths are predictable, so that when one is overhead, a target can counter its operations through deception or just ceasing activity. Persistent ISR stratostats make this impossible as their sensors are in position to monitor a target constantly, for weeks or longer on end.

Several new military stratostat concepts have been developed for high-persistence ISR in the past 20 years. All of these rely on detailed understanding of the dynamics of the stratosphere for their unique mission profiles. This includes a

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program the U.S. Department of Defense undertook in 2019 called COLD STAR, Covert Long-Dwell Stratospheric Architecture. Little has been revealed about this program other than the system comprises several stratostats that are low observable to radar and can remain over areas of interest. They reportedly can carry high power sensors to detect several types of weapon systems, including hypersonic missiles.

DARPA, the U.S. Department of Defense's Defense Advanced Research Projects Agency, began testing ALTA (Adaptable Lighter Than Air) stratostats in June of 2019. The agency has disclosed little about ALTA, other than it launched three stratostats from Maryland and that the balloons have traversed much of the eastern half of the conterminous United States. The balloons, according to DARPA, fly at altitudes above 75,000 feet and "...navigate by changing altitude and thus taking advantage of different wind profiles aloft." The system incorporates a "Winds Aloft Sensor," or "WAS," to provide real-time stratospheric wind diagnostics. The WAS system enables the ALTA stratostats to more precisely navigate and it adds to the growing knowledge base of the stratosphere for future projects and missions.

The second notable advantage stratostats possess is their operational proximity to the earth's surface. Proximity to a target is the most critical factor for the effectiveness of an ISR sensor—the closer, the better, in that more detail can be observed. The reasons are highly technical and relate to how electromagnetic radiation, including visible light, propagates and can be resolved. A sensor onboard a stratostat operating at 100,000 feet will provide results many orders of magnitude

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greater in quality than that same sensor will provide at 800,000 feet, which is the absolute closest any ISR satellite passes above the earth (most satellites operate far higher). To collect the same quality of ISR data from a satellite that can be collected from a stratostat—for any type of intelligence—the satellite’s sensor needs to be much, much larger and hence much heavier. This is due to a concept called “aperture,” vernacular term intelligence specialists use referencing the raw amount of electromagnetic radiation that can pass through and be collected by a sensor.

EDITORS: RECOMMEND PLACING SIDEBAR 2 HERE

Killeen-23:

On February 4, 2023, the Chinese ISR balloon drifted over the Atlantic Ocean off the coast of Myrtle Beach, South Carolina. A U.S. Air Force F-22 Raptor shot it down and then the U.S. Navy recovered the debris. Documents classified as secret and top secret that were leaked months later revealed that the balloon had a name: Killeen-23. The name wasn’t given by the Chinese military, but by the United States National Security Agency, the NSA. Killeen-23 was one of several ISR balloons that the NSA had tracked and named in the previous years.

The NSA estimated that the solar panels onboard the balloon could generate upwards of 10,000 watts. “This is about the same amount of power as a geostationary communications satellite uses...and is more than enough power to

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operate any ISR capabilities, including synthetic aperture radar,” read a (leaked) top secret assessment. Synthetic aperture radar, or SAR, is a specialized form of radar that can produce high-resolution, 3-dimensional representations of landscapes. It can operate in all weather, from all altitudes, and at any time of day.

The documents discussed details of other Chinese ISR stratostats, including one that circled the world from December 2021 to May of 2022 in the stratosphere, and one that passed over a U.S. Navy carrier strike group in the Pacific Ocean. The documents note the use of full motion video capabilities with optical zoom, a gimbaled parabolic dish (which was likely part of a satellite communications system), and multiple antennas that likely were components of sensor packages.

The specific mission and capabilities of Killeen-23 and whether it had flown along an intended route or had blown off course remains unknown outside of a small handful of people. However, the stratostat likely was being used to gather imagery intelligence data, a variety of signals intelligence data (including cyber data from wireless networks), and possibly measurement and signature intelligence data. It was certainly gathering meteorological intelligence data—for other ISR missions and to increase the level of understanding of stratospheric conditions for other systems, including weapon systems. Killeen-23 carried several commercial off-the-shelf (COTS) systems that reportedly originated outside of China, including satellite communications systems.

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Modern ISR craft do not operate insularly. The data that they generate is fused with data from other intelligence gathering platforms—satellites, ground-based sensors, manned aircraft, and unmanned aerial vehicles—to paint the most comprehensive, highest resolution picture possible. The Hudson Institute, an American research foundation, published a report titled “Regaining the High Ground Against China: A Plan to Achieve US Naval Aviation Superiority This Decade” in April of 2022. The research report discusses specific examples of incorporating ISR stratostats into military operations using a broad variety of manned and unmanned aircraft and surface vehicles. The authors of the paper explain that the stratostats could perform roles other than ISR, including communications relay and weapons control.

Scientists and the military have experimented with and operate several “distributed aperture” systems. This includes the Very Large Array, a cluster of radio telescopes in New Mexico that, when operated in unison, act as one massive sensor peering deep into space. Groups of stratostats, like the three DARPA Adaptable Lighter Than Air (ALTA) stratostats tested in 2019, can similarly work in concert with one another to provide wide-field, high-resolution coverage of an area of interest. This includes surface imagery, technical intelligence pictures, and data about the stratosphere through which they drift.

While details of the mission that Killeen-23 was performing may not be publicly known for decades (if ever), its presence was a bold sign that the use of military lighter-than-air vehicles for ISR is likely to increase. Of all LTAs, stratostats like

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Killeen-23 and DARPA's ALTA system hold the greatest promise for future utility. While ongoing development is veiled in secrecy, it is clear that both China and the United States see great potential for expansion of stratostat development and deployment. Their specific characteristics and capabilities will evolve due to several factors, notably how they may complement the capabilities of other ISR systems. Without a doubt, however, continuous study of the stratosphere and the "spy winds" that propel these craft will certainly remain one of the most crucial roles they perform.

**SIDEBAR 1: The Greatest Airship Disasters in History – All Caused by
Weather**

On May 6, 1937, LZ 129 *Hindenburg*, the largest aircraft ever built, famously burst into flames while landing at Lakehurst Naval Air Station in New Jersey, killing 36. Despite its enduring notoriety, the *Hindenburg* tragedy was not the deadliest airship incident on record. The three deadliest, which have been virtually forgotten by history, were all caused by weather events. In order of occurrence:

On December 21, 1923, the French Navy's *Dixmude*, which measured 743 feet, 2 inches in length, exploded off the coast of Sicily after a lightning strike during a thunderstorm. All 53 onboard perished.

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On October 5, 1930, heavy rain and violent gusts downed the 777-foot-long British airship R101 in France after crossing the English Channel. The crash killed 48 of 54 on board.

On April 4, 1933, the U.S. Navy's 785-foot-long USS *Akron* flew into a violent band of thunderstorms off the coast of New Jersey. The airship crashed into the sea due to violent gusts, killing 73 of the 76 on board.

SIDEBAR 2: Types of Intelligence Data That LTAs Can Collect:

The military intelligence process is a highly structured system comprising several phases. These phases include collections of raw data, processing this data into useful information, and then packaging this information into usable “products” for “customers” to interpret. Specialists work with several types of intelligence data, from human intelligence, or HUMINT, that involves direct human communication, to highly technical types of intelligence data that is collected by specialized sensors. The types of military intelligence data that lighter-than-air vehicles can collect span a wide range, all of which are technical in nature and require the use of sophisticated sensors. The following is a comprehensive list:

Meteorological Intelligence: While not widely discussed, meteorological intelligence, or weather intelligence (informally referenced as WxINT), is immensely important to all aspects of military operations. Long-endurance lighter-than-air vehicles, particularly stratostats, can provide continuous data on a broad spectrum of environmental conditions of an area of interest. DARPA's Winds

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Aloft Sensor (WAS), part of its ALTA project, is an example of a precision sensor for meteorological intelligence.

Imagery Intelligence – IMINT: Imagery intelligence includes still and motion imagery of subjects of interest. The most common subjects are those of and on the planet’s surface. Sensors include still and motion cameras that operate in the visible light spectrum as well as in the infrared spectral bands.

Geospatial Intelligence – GEOINT: This includes physical features of the planet, both natural and human-made. Imagery intelligence data used for this form of intelligence is considered GEOINT. Sensors may include still and motion cameras, radar systems, and LiDAR (light detection and ranging).

Signals Intelligence – SIGINT: Signals intelligence data is sourced by the interception of electronic signals, including cellular telephone signals, radar signals, telemetry signals, and others. SIGINT is a highly specialized, highly technical form of intelligence for which lighter-than-air vehicle platforms are exceptionally well suited due to their persistence capabilities and their proximity to the planet’s surface. SIGINT comprises several subcategories: **Communications Intelligence – COMINT:** Any type of communication signals, including voice, data, and telemetry. **Electronic Intelligence – ELINT:** Non-communications signals, including radar and jamming systems. ELINT is one of the most technically sophisticated forms of intelligence. **Foreign Instrumentation Signals Intelligence – FISINT:** This is a highly specialized form of intelligence that

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gathers signals generated through the testing and deploying of foreign technical systems. The intercepted signals are typically specially coded machine-to-machine languages intermixed with natural language.

Measurement and Signature Intelligence – MASINT: This is one of the least-understood, most specialized, and most useful forms of intelligence. According to the United States Defense Intelligence Agency, MASINT identifies “...the intrinsic characteristics and components of an object or activity.” It does this by making a precision analysis of specific characteristics of a target (signature) and / or recording its uniquely identifying spatial and / or temporal dimensions (measurement). For example, when fired, a machine gun produces a repeating flash. Analyzing the color, size, and pattern of the flash and measuring the interval between individual flashes can yield the type of machine gun being fired. MASINT comprises a broad variety of individual forms of intelligence sensing, including acoustic, nuclear, radar and radiological, visible wavelength light, infrared light, and others.

Cyberspace Intelligence – CYBERINT: This is the analysis of cyberspace activity. LTA-based sensors can collect cyber data that is transmitted through wireless networks.

Due to miniaturization of components, most ISR aircraft, of all types, carry several types of sensors, providing “multi-INT” capabilities, and many forms of intelligence span multiple fields. For example, many types of imagery intelligence

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products are used for geospatial intelligence efforts, and cyber activity that is intercepted over a wireless network could be considered signals intelligence.

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