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Public Water System Drone Guide

A drone can fly outdoors where few people want to go, to inspect the exterior of elevated water storage tanks, and the equipment attached to them, efficiently and as often as needed. The photos and videos collected can be saved and compared through time to denote the rate of changes or the period of a discrete event.

The use of drones – the name most people use in reference to remote-controlled quad-copters - has been steadily growing in a wide variety of industries, not to mention the recreational pursuits of many people. The more technical name for all the tools used to fly devices remotely is the regulated aeronautical specialty of Unmanned (or alternatively, Uncrewed) Aerial Systems, or UAS. Remote-controlled aircraft are used in agriculture to evaluate crops and inspect center pivots. Law enforcement uses drones in crime-scene investigations, searches and surveillance. Hundreds of synchronized drones outfitted with LED lights are being used like fireworks to entertain audiences with creative displays in the night sky. There is a place for UAS in public water system management and operations, too. But before jumping into that, a review of the initial and ongoing requirements, and the potential benefits and the limitations are in order. Please note that the Federal Aviation Administration (FAA) can and will likely update the rules and regulations for small Unmanned Aerial Systems (sUAS) at any time, and continue to do so as the industry expands.

Hobbyist vs. commercial pilot

What is the difference between a recreational drone pilot and a commercial drone pilot? The answer is, not that much. Both have generally the same rules of compliance with their aircraft, but recreational users are not required to be licensed as a Remote Airman or Pilot. Recreational or hobbyist drone pilots must pass an online test administered by an approved testing provider, and carry with them the certificate showing that a passing grade was achieved, when flying. Drones flown for the enjoyment of flying and for the personal enjoyment of any video or photos collected during flight falls under the recreational exemption. A pilot recording video or taking photographs as a service, whether a financial transaction occurred or not, would not be exempted as a recreational user. Drones flown for non-recreational purposes must be piloted by pilots that have passed a more difficult FAA exam demonstrating knowledge and understanding of 14 CFR Part 107 (a.k.a. the Small UAS Rule).

There is another exemption for the recreational pilot. Drones weighing less than 249 grams or 0.55 pounds flown by recreational pilots do not need to be registered with the FAA, at present. Remote Airman licensed pilots must register their small aircraft regardless of the weight. While the date has been pushed back many times, registered drones will be required to broadcast their FAA registration number by September 16, 2023. While many toy drones weigh less than 249 grams, there are also professional-level drones below that weight that can capture video worthy of being used in Hollywood movies. Drones that fly with a weight of more than 55 pounds, including their payload if any, are registered as traditional aircraft.

While it is theoretically possible to do self-study to learn the various topics found on the FAA's 60-question test, the 3-day course offered at Kansas State University – Polytechnic Campus

in Salina, Kansas, was very helpful for the author to learn regulations for the operation of drones. The course was also extremely helpful to learn about the many sources of regulation compliance and pre-flight information required before initiating a flight. K-State also proctors the FAA examination on the day following the 3-day course. In addition to the small UAS Commercial Remote Pilot Training course, K-State-Salina offers courses in Basic and Advanced Multirotor Flight Training, Drone Imagery Collection, Mapping and Analysis Training, UAS Fire and HAZMAT Response Training, Law Enforcement Training and Night Operations Training. Those interested in learning more about the pilot training at K-State Polytechnic should access the K-State website at polytechnic.k-state.edu/uas.

Flight restrictions on drones

Having a licensed pilot and a registered drone are not the only restrictions on operating small uncrewed aerial devices. Drones must be flown within the pilot's visual line of sight, or within the sight of a visual observer who can communicate with the pilot. This communication must be effective enough to communicate to the pilot the need to avoid other aircraft, people on the ground, obstructions, etc. Drones must stay more than 500 feet below clouds, at least 2,000 feet away from clouds horizontally, and never above the clouds. The maximum altitude that a drone can be flown is 400 feet above the land surface. However, the inspection of a tower, tank or structure can be done with a drone flying 400 feet over the object, if within 400 feet horizontally of the object. Atmospheric visibility must be no less than three miles.

Who owns the airspace?

Common law regarded ownership of land to start at the surface and extend downward to the center of the earth. In the other direction, common law ownership was considered to extend "to the heavens." When the Wright Brothers started flying their motorized airplane in 1903, there was no concept of public airspace over private property. It was not until 1940 that the U.S. Congress declared that the government had the sovereign right to possess and exclusive control of the airspace over the United States and that the public had the right to use the navigable airspace. Navigable airspace was defined in 1976 to be the minimum altitude of safe flight as defined by the Civil Aeronautics Authority. On the private airspace side, a North Carolina farmer with the last name of Causby won a lawsuit in 1946 in which the U.S. Supreme Court gave guidance that landowners have "exclusive control of the immediate reaches of the enveloping atmosphere" and that landowners own at least as much of the space above the ground as they can occupy or use in connection with the land. As with many court decisions, no numbers were provided to help define "enveloping atmosphere", etc.

The FAA has taken the position that sUAS vehicles are aircraft, and therefore the navigable airspace has been significantly expanded (lowered) into the areas formerly considered and established by court decisions to be private airspace. This conflict of private and public airspace should be, and likely will be debated and resolved

by Congress, at some point in the future. When this will happen is unknown.

The knowledge required by students wanting to be sUAS pilots, includes the various classes of airspace established by the FAA. While drones won't be operated in many of these zones, being a pilot requires an understanding of all of them. The following is a summary of all the classes.

The upper reaches of the atmosphere is **Class A**. Commercial jet aircraft cruise through Class A which is located from 18,000 feet to 60,000 feet above mean sea level (MSL).

Class B (think "Busy") airspaces are found surrounding the major airports, and are shaped like upside-down wedding cakes. At Kansas City International (KCI) Airport, the lower tier (mainly within 6 nautical miles of the airport) starts at the surface and goes to 8,000 feet MSL. The second tier, from 6 to 10 nautical miles has a floor of 2,400 feet MSL and extends up to 8,000 feet MSL. The third tier, from 10 to 15 nautical miles, has a floor of 3,000 feet MSL and a ceiling of 8,000 feet MSL. The fourth tier, from 15 to 20 nautical miles, has a floor of 4,000 feet MSL and a ceiling of 8,000 feet MSL. (These elevations are specific for KCI). The operation of drones under Zone B does not require air traffic control permission, but as with KCI and likely others, other zones for other airports need to be recognized. The airspace surrounding KCI is the only Class B airspace over Kansas.

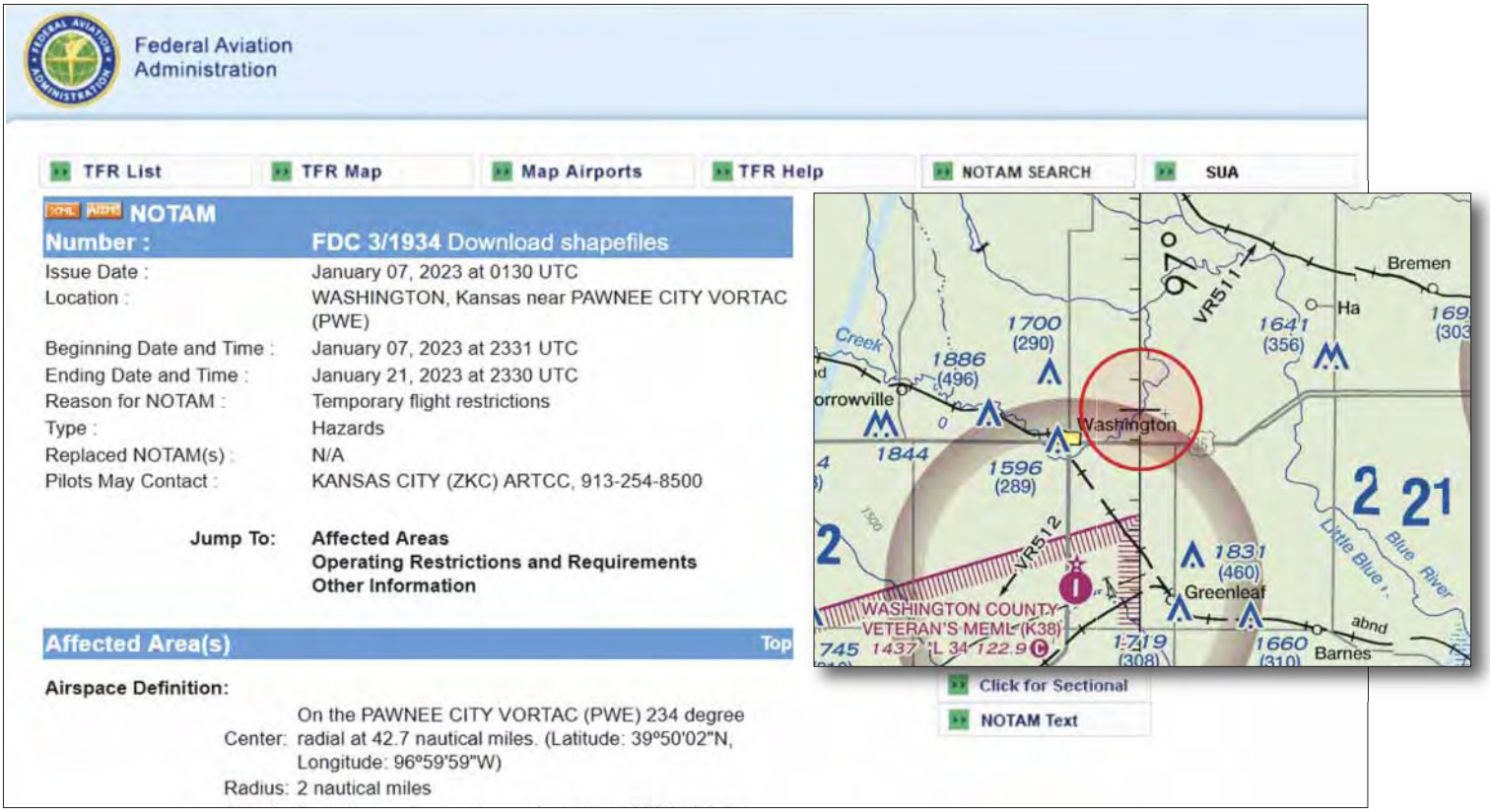
Class C (think "Congested") airspace is present around airports like Wichita's Dwight D. Eisenhower International Airport. The airspace is also like an upside-down wedding cake, and at Wichita, the second tier is 5 to 10 nautical miles from the airport with a floor of 2,700 feet MSL and a ceiling of 5,300 feet MSL. This Class C airspace is the only one in Kansas.

Class D (think "Mildly Dense") airspace is quite common in Kansas. it typically has a radius of 5 nautical miles from airports with a control tower and includes the surface to 2,500 feet above ground level (AGL). Notice the change from above ground level to mean sea level. At airports where the tower does not operate 24 hours a day - 7 days a week, the Class D airspace converts to Class E when the tower is closed.

Class E (think "Easy") airspace is present above many of the municipal airports in Kansas. Class E airspace is all of the controlled airspace that isn't classified as Class A, B, C, or D. In the areas absent of Classes B, C and D, Class E exists below the floor of Class A at 18,000 feet MSL. The floor of Class E is at 1,200 feet AGL, except at the airports so designated. Because small UAS vehicles seldom operate above 400 feet AGL, Class E airspace is not an issue, except where it has been established near an airport. The busier Class E airports like Hays Regional Airport have an inner Class E that extends from the surface to the floor of Class A. The outer Class E airspace at Hays has Class E airspace with a floor at 700 feet AGL.

Class G (think "General" or "Ground") is all of the remaining airspace in the United States. As it is uncontrolled airspace, no permission from the FAA is needed to operate a drone in Class G airspace.

There are also special airspace restrictions that are permanent or are



The FAA has established a temporary "No-Fly-Zone" for the airspace extending from the ground surface to an altitude of 2,000 feet above the ground, with a radius of 2 miles around an oil spill from the Keystone Pipeline in Washington, County, until at least January 21, 2023.

temporary. There are the environs of military installations where drone flights are prohibited. All national parks and monuments have drone prohibitions. Large sporting events like the Super Bowl have temporary restrictions. Areas of planned visits of the President of the United States get restricted. Rocket launches, and they don't always happen in Florida anymore, will have a temporary restriction placed in the vicinity of the launch pad. An example of a temporary airspace restriction in Kansas is one in Washington County. The TC Energy Corporation was able to convince the U.S. Department of Transportation and FAA that their remediation activities at the December 7 & 8, 2022, oil pipeline spill site near Washington, Kansas, needed a temporary airspace closing. It was claimed that aircraft flights lower than 2,000 feet AGL, which includes drones, were a dangerous distraction to their and their contractors' employees.

The drone pilot that finds that his or her drone will be operating in controlled airspace will need to request permission from the FAA before launching. Many different websites and smartphone apps can send the pertinent location and drone information to the FAA, and approval, if warranted, can be granted in a matter of minutes. This notification and approval system is known as Low Altitude Authorization and Notification Capability (LAANC). This approval system is currently in place around 726 U.S. airports. If a "complicated" waiver is needed, or LAANC is not available at a particular airport, drone pilots are advised to allow up to 90 days to get a manual review and approval of the proposal.

How's the weather outside?

Much of the required knowledge to obtain a remote pilot license involves the atmosphere, the weather and how to obtain and interpret the information provided by the National Weather Service and other weather data providers. Aircraft flight behavior is also a tested body of knowledge. Visibility is crucial for the pilot of a remotely controlled aircraft to avoid collisions with other aircraft, obstructions and people on the ground. The understanding of the restrictions on operating near clouds and in fog covers the vast majority of what pilots of small drones capturing video need. But because the FAA classifies those who fly small drones as pilots, their weather and aeronautical knowledge has to be minimally comparable to the knowledge held by pilots of large drones and aircraft with onboard personnel.

What can a certified pilot and a drone do for a public water system?

The most obvious function that a drone can perform for a public water system is visible observations of

Drone pilots must not only know where their unmanned aircraft is located visibly when in flight, but also be aware of any approaching aircraft. There is no airspace in which a drone has the right-of-way.

infrastructure that is difficult to impossible to see from the ground. A drone can go where few people can and most don't likely want to go, in a manner that is much cheaper and much, much safer than climbing a multi-story ladder. A drone can record photographs and videos of elevated storage tanks and standpipes, which can be compared through time, to determine how fast a maintenance issue is progressing. A drone can see if a recent storm has damaged the infrastructure or any of the equipment attached to it.

What about leak detection on pipelines? A drone can probably find unexplained green vegetation near a leaking pipeline if the ground surrounding the leak is dry and has been for a long period. The conditions would have to be right and might never happen for months, however. Average to above-average rainfall might not provide any extra green vegetation. Purchasing a drone and training an employee just for visual leak detection would likely not be economically justifiable. However, a large leaky water system might be able to justify using thermography to justify the purchase of a sUAS.

The author's very simple and brief search for a drone capable of recording thermal data finds that the cost of the drone and thermal camera is at least 5 times more expensive than the under-249 gram drone, camera and controller he purchased, however. In addition to pilot training, there is training required to calibrate the thermal camera and interpret the collected data. Heavy vegetation (trees, brush, grass) may also limit the thermal camera-equipped drone's ability to capture heat / cold signatures representative of a water leak.

At this time, it still appears to be too early for most public water systems to add an Unmanned Aerial System to their toolbox. Water systems with multiple elevated water storage tanks may be able to justify the cost of a drone when it is compared to the time and cost of sending personnel to inspect the top of a tank. It may be even more cost-effective to invite the local law enforcement or fire department sUAS pilot to practice their piloting skills with their drone to collect the information needed by the water system. These agencies will likely have the thermal collecting and analysis equipment too.

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