

# When drones fall from the sky

Story by Craig Whitlock

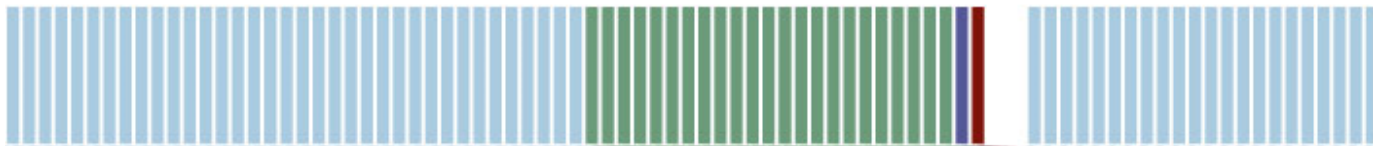
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More than 400 large U.S. military drones have crashed in major accidents around the world since 2001, a record of calamity that exposes the potential dangers of throwing open American skies to drone traffic, according to a year-long Washington Post investigation.

Since the outbreak of the wars in Afghanistan and Iraq, military drones have malfunctioned in myriad ways, plummeting from the sky because of mechanical breakdowns, human error, bad weather and other reasons, according to more than 50,000 pages of accident investigation reports and other records obtained by The Post under the Freedom of Information Act.

## Crashes around the world

## Where the drone crashed



## Who owns the drone



## Type of drone



[VIEW GRAPHIC](#)

Commercial drone flights are set to become a widespread reality in the United States, starting next year, under a 2012 law passed by Congress. Drone flights by law enforcement agencies and the military, which already occur on a limited basis, are projected to surge.

The documents obtained by The Post detail scores of previously unreported crashes involving remotely controlled aircraft, challenging the federal government's assurances that drones will be able to fly safely over populated areas and in the same airspace as passenger planes.

Military drones have slammed into homes, farms, runways, highways, waterways and, in one case, an Air Force C-130 Hercules transport plane in midair. No one has died in a drone accident, but the documents show that many catastrophes have been narrowly averted, often by a few feet, or a few seconds, or pure luck.

“All I saw were tents, and I was afraid that I had killed someone,” Air Force Maj. Richard Wageman told investigators after an accident in November 2008, when he lost control of a Predator that plowed into a U.S. base in Afghanistan. “I felt numb, and I am certain that a few cuss words came out of my mouth.”



Air Force Maj. Richard Wageman operates a Predator from a ground-control station in Afghanistan on Oct. 25, 2008. A week later, he was the pilot of a Predator that crashed into a U.S. military base. The precise cause of the crash was undetermined. (U.S. Air Force photo)

Investigators were unable to pinpoint a definitive cause for the accident but said wind and an aggressive turn by the pilot were factors. Wageman did not respond to a request for comment through an Air Force spokeswoman.

Several military drones have simply disappeared while at cruising altitudes, never to be seen again. In September 2009, an armed Reaper drone, with a 66-foot wingspan, flew on the loose across Afghanistan after its handlers lost control of the aircraft. U.S. fighter jets shot it down as it neared Tajikistan.

The documents describe a multitude of costly mistakes by remote-control pilots. A \$3.8 million Predator carrying a Hellfire missile cratered near Kandahar in January 2010 because the pilot did not realize she had been flying the aircraft upside-down. Later that year, another armed Predator crashed nearby after the pilot did not notice he had squeezed the wrong red button on his joystick, putting the plane into a spin.

While most of the malfunctioning aircraft have perished in combat zones, dozens have been destroyed in the United States during test and training flights that have gone awry.

In April, a 375-pound Army drone crashed next to an elementary-school playground in Pennsylvania, just a few minutes after students went home for the day. In Upstate New York, the Air Force still cannot find a Reaper that has been missing since November, when it plunged into Lake Ontario. In June 2012, a Navy RQ-4 surveillance drone with a wingspan as wide as a Boeing 757's nose-dived into Maryland's Eastern Shore, igniting a wildfire.

Defense Department officials said they are confident in the reliability of their drones. Most of the crashes occurred in war, they emphasized, under harsh conditions unlikely to be replicated in the United States.

Military statistics show the vast majority of flights go smoothly and that mishap rates have steadily declined over the past decade. Officials acknowledge, however, that drones will never be as safe as commercial jetliners.

“Flying is inherently a dangerous activity. You don’t have to look very far, unfortunately, to see examples of that,” said Dyke Weatherington, director of unmanned warfare for the Pentagon. “I can look you square in the eye and say, absolutely, the [Defense Department] has got an exceptional safety record on this and we’re getting better every day.”

The Post’s analysis of accident records, however, shows that the military and drone manufacturers have yet to overcome some fundamental safety hurdles:

- **A limited ability to detect and avoid trouble.** Cameras and high-tech sensors on a drone cannot fully replace a pilot’s eyes and ears and nose in the cockpit. Most remotely controlled planes are not equipped with radar or anti-collision systems designed to prevent midair disasters.
- **Pilot error.** Despite popular perceptions, flying a drone is much trickier than playing a video game. The Air Force licenses its drone pilots and trains them constantly, but mistakes are still common, particularly during landings. In four cases over a three-year period, Air Force pilots committed errors so egregious that they were investigated for suspected dereliction of duty.
- **Persistent mechanical defects.** Some common drone models were designed without backup safety features and rushed to war without the benefit of years of testing. Many accidents were triggered by basic electrical malfunctions; others were caused by bad weather. Military personnel blamed some mishaps on inexplicable problems. The crews of two doomed Predators that crashed in 2008 and 2009 told investigators that their respective planes had been “possessed” and plagued by “demons.”
- **Unreliable communications links.** Drones are dependent on wireless transmissions to relay commands and navigational information, usually via satellite. Those connections can be fragile. Records show that links were disrupted or lost in more than a quarter of the worst crashes.

Among the models that crashed most often is the MQ-1 Predator, the Air Force drone manufactured by General Atomics Aeronautical Systems, of San Diego. Almost half the Predators bought by the Air Force have been involved in a major accident, according to purchasing and safety data.

Frank W. Pace, president of aircraft systems for General Atomics, the leading producer of large military drones, said the Predator has exceeded expectations for reliability. It was designed to be lightweight and inexpensive, costing less than \$4 million apiece. During the early years of the wars in Afghanistan and Iraq, he said, nobody expected the Predator to last very long.

“It was more of a mind-set that you were going to get shot down or have other losses, so you don’t want to put all this money into a redundant system,” Pace said, referring to backup systems designed to kick in when a failure occurs.

He emphasized that none of the Predator accidents have been fatal.

“We’ve never reported a loss of life,” he said, “so we’re doing pretty good.”

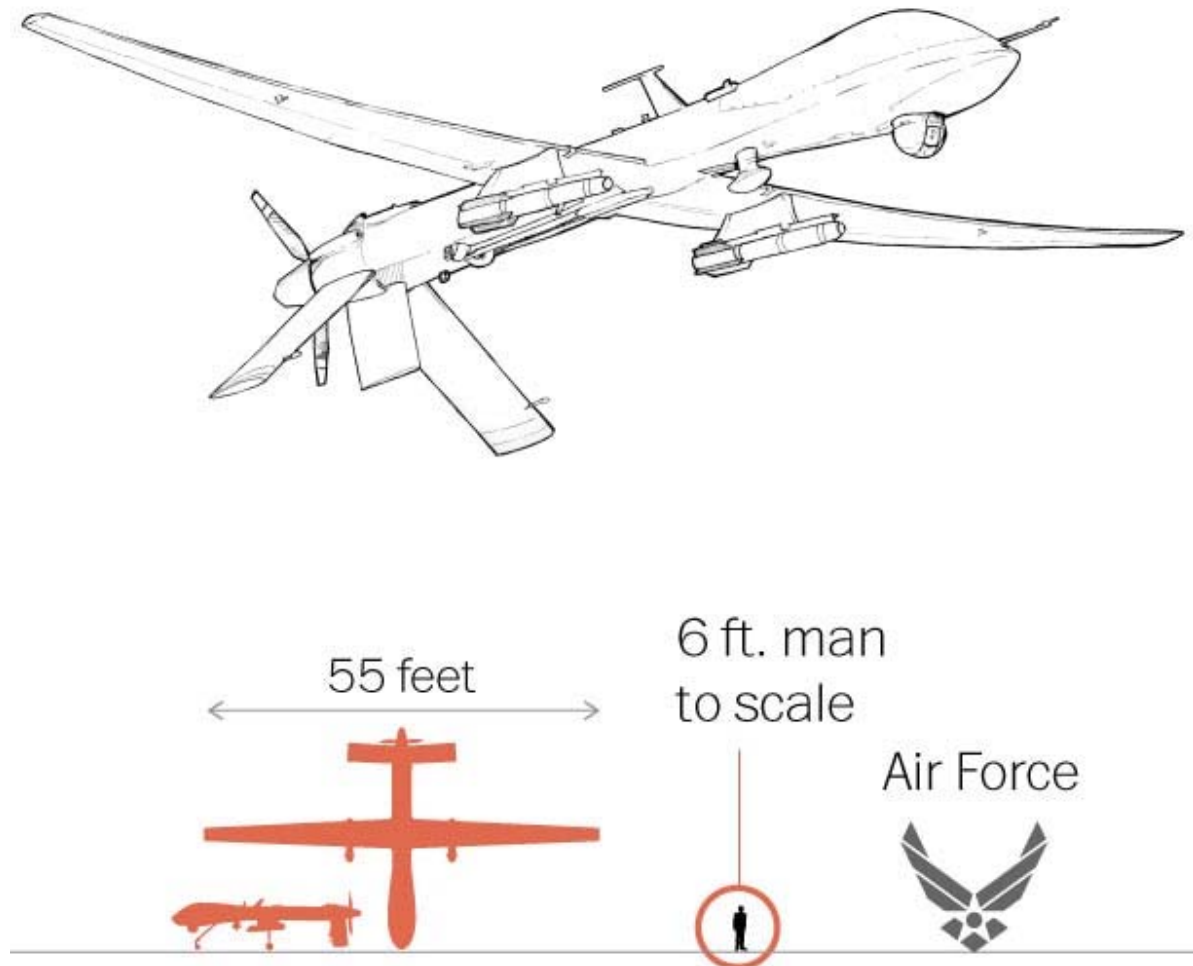
## Accidents span globe

Drones have revolutionized warfare. Now they are poised to revolutionize civil aviation. Under the law passed by Congress, the Federal Aviation Administration is scheduled to issue rules by September 2015 that will begin the widespread integration of drones into civilian airspace.

Pent-up demand to buy and fly remotely controlled aircraft is enormous. Law enforcement agencies, which already own a small number of camera-equipped drones, are projected to purchase thousands more; police departments covet them as an inexpensive tool to provide bird’s-eye surveillance for up to 24 hours straight.

Businesses see profitable possibilities for drones, to tend crops, move cargo, inspect real estate or film Hollywood movies. Journalists have applied for drone licenses to cover the news. Amazon.com chief executive Jeffrey P. Bezos wants his company to use autonomous drones to deliver small packages to customers’ doorsteps. (Bezos also owns The Post.)

## MQ-1 Predator



First flown in 1994, it later became the first weaponized drone. Designed to conduct surveillance with powerful cameras and sensors, it can be armed with laser-guided Hellfire missiles. It often stays aloft on missions for more than 20 hours at a time and can reach an altitude of 25,000 feet. (Alberto Cuadra)

**SEE MORE DRONE TYPES**

The military owns about 10,000 drones, from one-pound Wasps and four-pound Ravens to one-ton Predators and 15-ton Global Hawks. By 2017, the armed forces plan to fly drones from at least 110 bases in 39 states, plus Guam and Puerto Rico.

The drone industry, which lobbied Congress to pass the new law, predicts \$82 billion in economic benefits and 100,000 new jobs by 2025.

Public opposition has centered on civil-liberties concerns, such as the morality and legality of using drones to spy on people in their back yards. There has been scant scrutiny of the safety record of remotely controlled aircraft. A report released June 5 by the National Academy of Sciences concluded that there were “serious unanswered questions” about how to safely integrate civilian drones into the national airspace, calling it a “critical, crosscutting challenge.”

Nobody has more experience with drones than the U.S. military, which has logged more than 4 million flight hours. But the Defense Department tightly guards the particulars of its drone operations, including how, when and where most accidents occur.

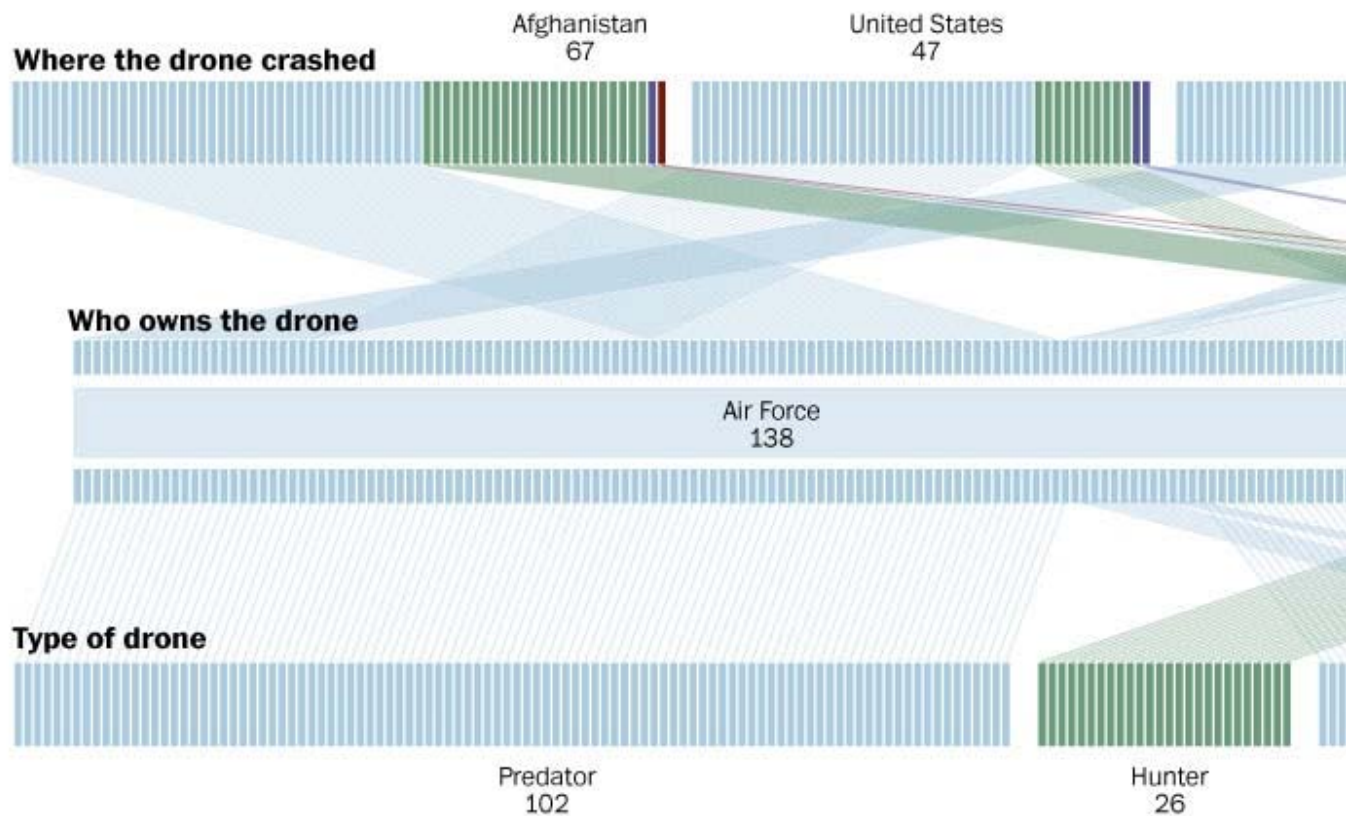
The Post filed more than two dozen Freedom of Information Act (FOIA) requests with the Air Force, Army, Navy and Marine Corps. Responding intermittently over the course of a year, the military released investigative files and other records that collectively identified 418 major drone crashes around the world between September 2001 and the end of last year.

That figure is almost equivalent to the number of major crashes incurred by the Air Force’s fleet of fighter jets and attack planes during the same period, even though the drones flew far fewer missions and hours, according to Air Force safety statistics.

The military divided the major accidents into two categories of severity, based on the amount of damage inflicted to the aircraft or other property. (There are three other categories for more minor accidents.)

According to the records, 194 drones fell into the first category — Class A accidents that destroyed the aircraft or caused, under current standards, at least \$2 million in damage.

Slightly more than half of those accidents occurred in Afghanistan and Iraq. Almost a quarter happened in the United States.



See the details behind 194 of the most severe drone crashes.[VIEW GRAPHIC](#)

In most instances, military officials convened an accident investigation board to determine the cause. In 18 cases, the drone crashes were so sensitive that the military classified the names of the countries where they occurred and details of what happened.

Two hundred and twenty-four drones crashed in Class B accidents that, under current standards, cost between \$500,000 and \$2 million. Officials withheld basic details about those mishaps, such as the dates and locations, on the grounds that the lesser damage totals did not warrant a public investigation.

The military documents do not include information about drones operated covertly by the CIA. The spy agency has its own fleet of about 30 armed Predator

and Reaper drones overseas, all flown remotely by Air Force pilots assigned to the CIA.

The CIA also flies highly advanced RQ-170 Sentinel surveillance drones, including one that U.S. officials have acknowledged went down in Iran in December 2011.

## **‘Hit by a UAV!’**

As the military dispatched drone after drone to Iraq and Afghanistan in the mid-2000s, some Air Force commanders saw the potential for trouble in the increasingly crowded skies.

Air Force leaders circulated briefing materials that quoted an unnamed general as saying, “What I worry about is the day I have a C-130 with a cargo-load of soldiers, and a [drone] comes right through the cockpit window.”

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—Unnamed general in Air Force briefing materials

The general’s worries were well founded. On Aug. 15, 2011, a C-130 Hercules weighing about 145,000 pounds was descending toward Forward Operating Base Sharana, in eastern Afghanistan. Suddenly, a quarter-mile above the ground, the huge Air Force plane collided with a 375-pound flying object.

“Holy shit!” yelled the Hercules’s navigator, according to a transcript of the cockpit voice recorder. “We got hit by a UAV! Hit by a UAV!”

It was an unmanned aerial vehicle, or UAV in military jargon. An RQ-7B Shadow, flown by an Army ground crew, had smashed into the cargo plane's left wing between two propellers. Jet fuel cascaded out of a gash in the wing.

The Hercules crew shut down one engine and radioed to clear the runway. Within two minutes, the plane landed, smoke pouring from the left side. "There's a big frickin' hole in the airplane," the pilot said, according to the cockpit voice recorder. No one was hurt.

About 50 seconds later, the unwitting drone operator radioed the control tower to confess he had lost track of his aircraft.

"We had a, ah, C-130, um, that hit a UAV," the air-traffic controller responded. "I'm suspecting that it's yours."

The collision pulverized the Shadow. As word spread, it left drone manufacturers and drone advocates in the military on tenterhooks. If investigators determined the drone crew was responsible for a midair disaster, it would undermine plans to fly robotic aircraft not just overseas but back in the United States.

The military has never publicly disclosed the outcome of the investigation. Two Pentagon officials said in interviews that the drone operator was not at fault, but they did not give further details.

In response to a FOIA request from The Post, the Air Force released hundreds of pages of documents from its safety probe. The official finding of what caused the crash was censored, but some of the documents suggest the air-traffic controller was at least partly blamed. The records show the controller, a civilian contractor whose name was redacted, was temporarily demoted and given remedial training.

Military officials said there has been only one other case of a midair drone collision, involving a helicopter and a small, hand-launched drone in Iraq a decade ago.

Close calls on the ground have been more frequent.





The wreckage of a Predator drone that crashed into Kandahar air base in May 2011. | An Afghan housing compound that was destroyed in another U.S. military drone crash in Jalalabad later that year. (U.S. Air Force photos)

**“Where the hell is — where is the runway?” screamed Air Force Capt. Matthew Scardaci as his engine conked out and his Predator crashed into Kandahar air base on May 5, 2011, according to a voice-recording transcript. “Oh shit, oh damn, oh my God what is that!? . . . What was all that stuff that I just hit?”**

A row of empty shipping containers, it turned out. Nobody was hurt. Scardaci did not respond to a request for comment through an Air Force spokeswoman.

In eastern Afghanistan, Predators armed with Hellfires crashed near residential areas in the city of Jalalabad twice in the space of six months.

In one instance, on Aug. 20, 2011, a drone “began falling out of the sky” after its propeller broke. “I looked below us, and there were houses everywhere,” the camera operator told investigators.

The Predator smashed into two Afghan housing compounds and sparked a fire. No one was hurt. The military compensated the homeowners with an undisclosed amount of money.

## ‘Oops’ and ‘uh-oh’

Inside ground-control stations, drone pilots sit with binders of checklists that guide them through every conceivable scenario. But costly errors are still easy to make.

One recurring mistake: forgetting to turn on the Stability Augmentation System, which prevents the drone from going wobbly or into a spin. In at least five cases, pilots did not switch it on, or accidentally switched it off, then sat perplexed as the aircraft went into a nose dive.

On Aug. 16, 2010, neither the pilot nor the camera operator noticed the bright red warning lights on the video screens in front of them when their Predator took off from Balad air base in Iraq with the stabilizer turned off.

“That’s freaking us!” the camera operator yelled as the drone crashed, leaving a hole three feet deep near the runway. “What in the hell happened?” Investigators blamed “pilot inattention” for the accident.

In four cases between 2009 and 2012, Air Force officials determined that pilots were willfully negligent, placing them under investigation for suspected dereliction of duty, a criminal charge under military law.

One flew a Predator, unintentionally, into a 17,000-foot Afghan mountain, even after he was warned to watch out for high terrain.

Investigators concluded that the inexperienced pilot was rushing to help troops on the ground and preoccupied with nearby storm clouds, unaware of the mountain looming ahead.

The accident reports do not disclose the outcomes of the dereliction-of-duty cases or identify the pilots. Air Force officials declined to elaborate.

In another dereliction case, voice-recorder transcripts show an irritated camera operator lecturing a habitually nervous pilot right before takeoff at Jalalabad on July 24, 2012.



A damaged Predator that crashed into a barrier at the airfield in Jalalabad in July 2012. (U.S. Air Force photo)

“Stop saying ‘uh oh’ while you’re flying,” the operator chided. “It’s never good. Like going to the dentist or a doctor . . . oops, what the f— you mean oops?”

Sure enough, a few minutes later — oops. The armed Predator rammed a runway barrier and guardhouse.

“Whoa,” the pilot said. “I don’t know what the hell just happened.”

## Reliability gripes

The original Predator was designed without redundant systems common to larger, manned aircraft. It bore only one engine, one alternator, one propeller. If any of those parts failed, the plane would come down.

Since the drone program began, the Air Force has acquired 269 Predators. Forty percent have crashed in Class A accidents, the most severe category. An additional 8 percent wrecked in Class B accidents.

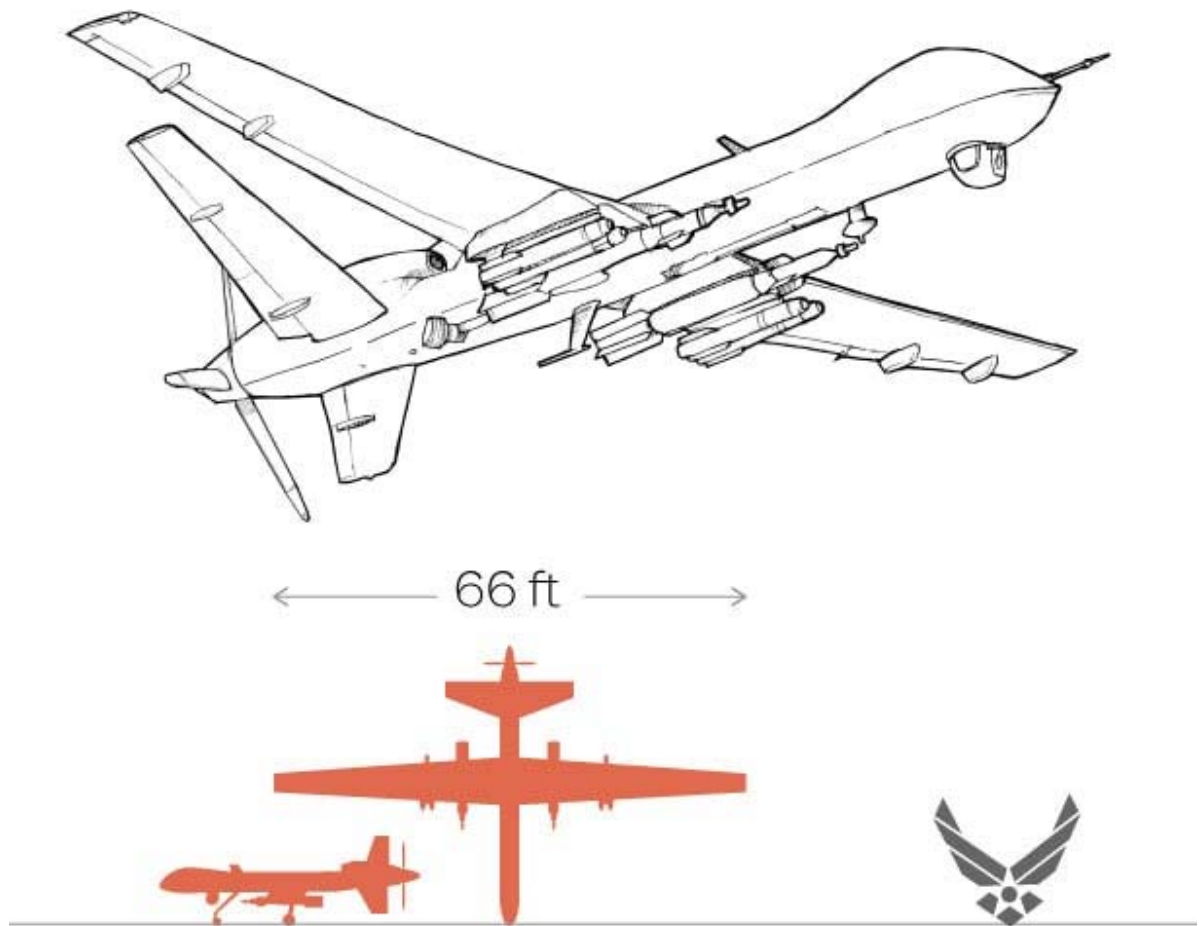
As the accidents piled up, Air Force crews griped about reliability. Some of the complaints were aimed at General Atomics, the manufacturer.

“I don’t want to be the one that crashes a plane, but I hope that this causes folks, and when I say folks, I mean GA [General Atomics], I hope we hold them accountable for some of this stuff,” Air Force Maj. Elizio Bodden, a Predator instructor pilot, told an accident investigation board after a crash in Iraq on Nov. 29, 2007. “We know we are flying with some defective stuff, but we still do it.”

Pace, the General Atomics executive, blamed most Predator accidents on pilot mistakes during landings. He said that the company has made some safety upgrades to the aircraft but that adding extra engines or duplicate power systems was not practical, because it would require “a big redo.”

He noted that the aircraft has a limited future. General Atomics ceased production of the original Predator model in 2011 and replaced it with the MQ-9 Reaper, a more reliable aircraft that can fly twice as fast and carry more missiles and bombs. The Air Force plans to stop flying Predators by 2018 and has not been “interested in putting their money into upgrades,” Pace said.

## MQ-9 Reaper



The bigger, faster and more reliable successor to the Predator. It can fly as high as 50,000 feet and carry four Hellfire missiles, twice as many as the Predator. The Air Force expects to replace all its Predators with Reapers by 2018. The civilian version of the MQ-9 is called the Predator B. (Alberto Cuadra)

#### SEE MORE DRONE TYPES

The Air Force acknowledged that Predators crash more frequently than regular military aircraft, but officials said the drone's safety record has improved markedly.

During its first dozen years of existence, the Predator crashed at an extraordinarily high rate — for every 100,000 hours flown, it was involved in 13.7 Class A accidents.

Since 2009, as the Air Force has become more experienced at flying drones, the mishap rate for Predators has fallen to 4.79 Class A accidents for every 100,000 flight hours.

## Army crash rates

The Reaper has fared better than the Predator, incurring 3.17 Class A mishaps per 100,000 hours over the past five years.

Air Force officials pointed out that the crash rate for Reapers now approaches the standard set by two fighter jets, the F-16 and F-15, which over the past five years have posted Class A mishap rates of 1.96 and 1.47 respectively, according to statistics from the Air Force Safety Center at Kirtland Air Force Base in New Mexico.

“We’ve learned a lot about flying [drones] because we had to,” said Air Force Col. James Marshall, the safety director for the Air Combat Command. “War is a great motivator when lives are on the line.”

The Reaper has not been immune to deficiencies.

After one crashed during a training mission in California on March 20, 2009, Air Force investigators blamed a faulty temperature control valve in the oil system. A similar incident had occurred one month before.

Further investigation revealed that sliders in the valves had been installed upside-down. Air Force inspectors were even more surprised to learn from General Atomics that the firm had bought the valves from a Houston company that did not design its products for use in airplanes.

The valve “is not of aerospace grade. In other words, the thermostatic valve was designed specifically for industrial applications ONLY,” an Air Force investigator

wrote in the accident report. “This thermostatic valve was not intended for aircraft.”



A faulty temperature control valve caused a Reaper to crash during a training mission in California in March 2009. (U.S. Air Force photo)

Unlike the Air Force, the Army does not make the argument that its drones are nearly as safe as regular planes.

In June 2013, Army safety officials posted a bulletin noting that their drones had crashed at 10 times the rate of manned Army aircraft over the previous nine months.

As bad as that number sounded, the officials said it actually understated the problem. Commanders were not reporting many drone mishaps, as required, to the Army Combat Readiness/Safety Center at Fort Rucker, Ala.

About 55 percent of the Army's MQ-5 Hunter drones, which can carry weapons, have been "lost for various reasons" in accidents during training and combat operations, according to Col. Tim Baxter, the Army's project manager for unmanned aircraft systems.

The RQ-7 Shadow, the smaller reconnaissance model that crashed into the Hercules cargo plane, has also been accident-prone. At least 38 percent of the Army's fleet has been involved in a major accident, according to a Post analysis of Army safety statistics.

## Into mountains, into the sea

The accident investigation reports describe a profusion of emergencies in which drones swerved so far out of control that crews had to resort to extreme measures to prevent catastrophes.

On six occasions between 2006 and 2012, records show, pilots intentionally flew straight into the side of a mountain after their aircraft's engines began to fail.

Under military guidelines, it was considered safer to ram a remote peak on purpose than to risk a drone falling on someone during a Hail Mary landing attempt at an airfield.

“He smashed it to smithereens,” an Air Force mission supervisor reported approvingly after a pilot struggling with a broken propeller motor commanded his Predator to strike a mountain in eastern Afghanistan on Oct. 26, 2012.

In several other cases, drones simply disappeared and were never found.

The nighttime skies were clear, with little wind, on July 10, 2011, when crew members who had been flying an armed Predator at an altitude of 16,500 feet over eastern Afghanistan saw their screens go blank. The satellite links had gone down. Despite hours of searching, nobody could find the plane on radar. An airborne search also proved fruitless.

Large drones are equipped with transponders to broadcast their locations. If they lose all electrical power, the transponders do not work; most models do not carry battery-powered backup systems, because of the extra weight.

Such was the fate of an armed Predator that disappeared 20 minutes after taking off from Kandahar air base on Nov. 20, 2009. Searchers looked for two days but found no trace and declared it lost.

Five weeks later, troops stumbled across the wreckage, crumpled in the dirt seven miles from the base. Investigators determined the crash was caused by a “catastrophic electrical failure” triggered by a short-circuited alternator cable.

Lightning, high winds and icing can be especially lethal for drones.

On Dec. 13, 2012, a Navy helicopter drone was trying to land on the USS Robert G. Bradley, a guided-missile frigate, off the coast of Libya when the tail rotor shattered just 15 feet above the flight deck.

Witnesses saw a two-foot chunk of ice fall off the tail; investigators concluded that icy conditions were to blame. Luckily for the crew, the drone, an MQ-8B Fire Scout, veered into the sea at the last second, narrowly missing the ship.

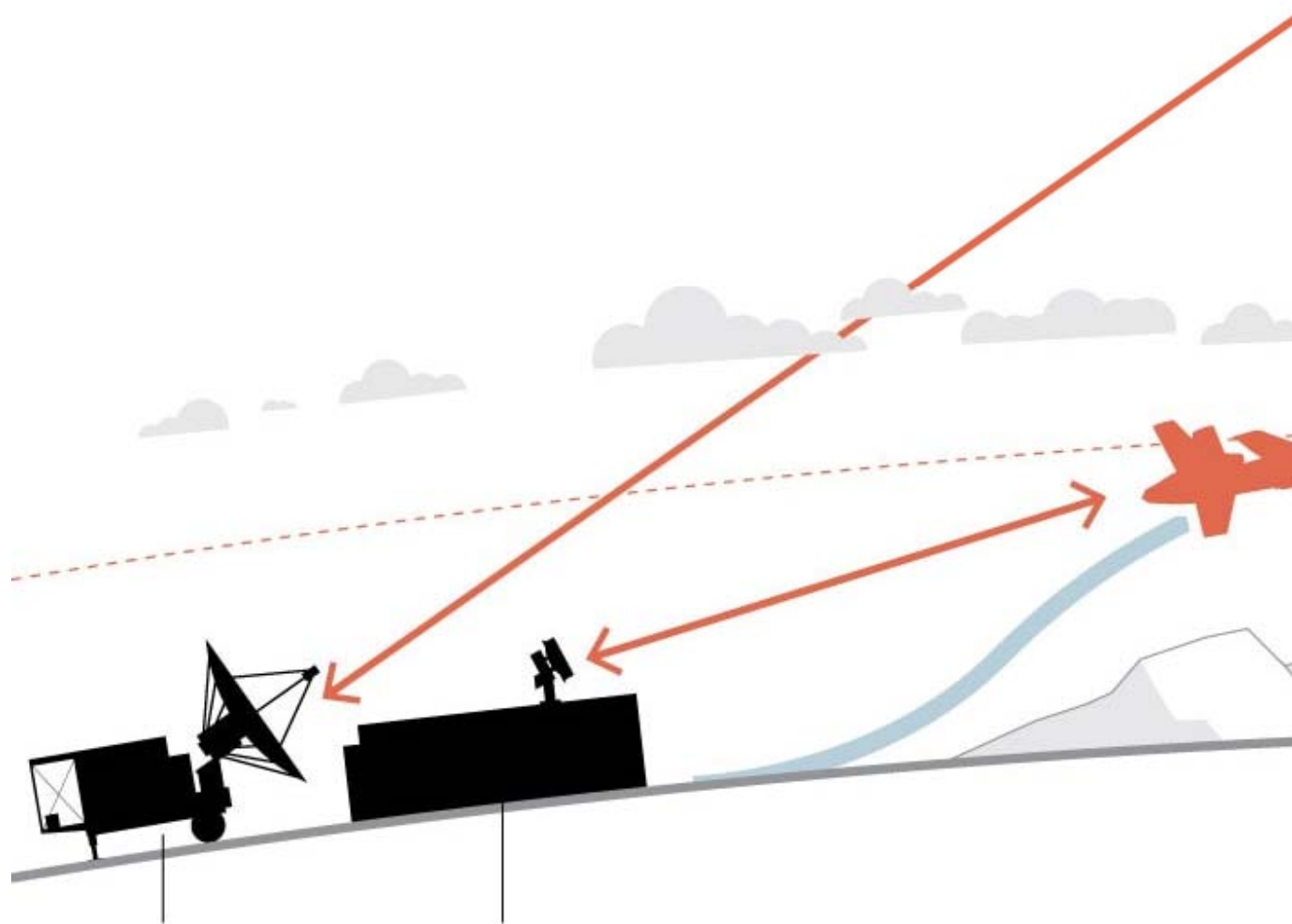
## Lost links

Drones depend on wireless links for navigation and control. Pilots and camera operators issue directions to the drone by a command link, usually by satellite. Data about the aircraft's movements and internal operations returns via a separate link.

## Pilots rely on satellites to track drones

From takeoff until it leaves the line of sight, the drone is controlled with a direct data link from a ground-control station.

If the communication link is lost, the drone is programmed to fly autonomously in circles until the link can be reconnected, or return to base.



Communications satellite

GPS satellite

Satellite antenna

Ground-control station

Target

When the drone leaves the line of sight, the ground-control station switches to a satellite link to control the aircraft. The drone also uses GPS to relay its position.

See which military drones are commonly involved in the crashes.[VIEW](#)

## GRAPHIC

Source: Air Force.

The links can be easily interrupted by various forms of interference. Usually, the outages last only a few seconds and are harmless. Just in case, drones are programmed to fly in a circular pattern until the links are restored. In worst-case scenarios, they are supposed to return automatically to their launch base.

Records show that does not always happen. In more than a quarter of the accidents examined by The Post, links were lost around the time of the crash.

Several pilots told investigators that they were so accustomed to lost links that they tended not to get nervous unless the disruptions lasted for more than a few minutes.

“I’d say after the three- or five-minute period, you sort of get the feeling that the plane just stopped talking to us and we may not recover this one,” a Predator pilot testified after an April 20, 2009, crash in Afghanistan.

Less than a month later, five hours into a reconnaissance mission over Afghanistan, a Predator lost its links and vanished in midair. Investigators never found the wreckage and were unable to determine a cause; the weather was clear, and there were no signs of mechanical problems or errors by the crew.

Satellite connections can be lost when a drone banks too sharply or drops in altitude too quickly. Electrical problems on the ground can also disrupt links.

On July 21, 2008, chaos erupted inside an Air Force ground-control station where crew members were flying three Predators simultaneously over Afghanistan. The station lost its power supply, and all its screens went black.

After several minutes, power was restored and pilots regained control over two of the Predators that had followed their programmed flight patterns and were flying in circles.

The third disappeared.