



## ENERGY

# Generation Next: How GE's Speedy Gas Turbines Are Helping California Power Into A More Sustainable Future

**Tomas Kellner**

September 29, 2021

Few U.S. states have been as tested by climate change as California. Heat, drought, wildfires and smoke have caused distress for residents and for utilities supplying them with electricity. To be sure, the most populous state has been aggressively adding renewables to lower its carbon emissions, but it also needs other sources of energy to supply baseload power when the sun stops shining, the wind stops blowing and water starts running low, affecting hydropower output.

But there's a way to achieve that: GE Gas Power's aeroderivative gas turbines. The turbines are essentially grounded jet engines that have been reconfigured to run on natural gas and generate electricity. They can be mounted on a trailer and quickly employed and connected to the grid. In California, GE and its local partners [finished the job](#) in just 42 days.

The parties involved in the project, which include the [State of California's Department of Water Resources](#), the government body responsible for managing the state's water supply, the engineering firm Kiewit Power Constructors Co., the power plant site owners and GE have installed — at the Davisville and Yuba City power plants, north of Sacramento — four GE

the Roseville and Yuba City power plants, north of Sacramento — four GE [TM2500 turbines](#) with a combined capacity of 120 megawatts. That amount of power is theoretically enough to supply the equivalent of

120,000 U.S. homes. “We are helping the state of California meet its renewables and carbon targets, while providing reliability to the electrical system when renewable resources are not sufficient to meet the state’s electricity demand,” said Eric Gray, Americas CEO at GE Gas Power.



*GE’s TM2500 units have logged more than 6 million continuous operating hours in 27 countries. Image credit: GE Gas Power. Top image: Getty Images.*

The turbines are called aeroderivative because their beating heart is technology GE Aviation originally developed for the [CF6 jet engine](#). The units can ramp up very quickly — just like lifting Air Force One, which uses four CF6 engines — and can also quickly power down. The GE aeroderivative turbines’ ability to generate power on demand within minutes makes it an effective bridge for utilities seeking to move away from baseload power supplied by coal and support more use of wind and solar power — which is all part of [GE’s larger gas and renewable power and sustainability strategy](#).

This is not the first time aeroderivative turbines have stepped up. Earlier this year, a utility in Colorado ordered six of the turbines to replace an aging coal-fired power plant in Colorado Springs. Once the aeroderivative gas units are up and running, [Colorado Springs Utilities](#) forecasts CO<sub>2</sub> emissions will decline 80% by 2030 — a big win for the community.

One version of the turbine fits on a large cargo jet, and GE deployed it in parts of the world that needed to quickly boost their electricity output. In [Lombok](#), an Indonesian island next to Bali, the robust machines can not only supply the local tourist and pearl industries, but also helped locals [power through a devastating earthquake](#) that struck the area in 2018. Mexican officials deployed the TM2500 [to work around](#) parts of the grid damaged by a hurricane that slammed the Baja California peninsula in 2014.

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#### TAGS

[natural gas](#)

[CF6](#)

[aeroderivative](#)

[TM2500](#)

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## [SPACE FLIGHT](#)

# Success In The Skies: Virgin Orbit's Cosmic Girl Launches Test Rocket

[Kristin Kloberdanz](#)

July 12, 2019

Just a week after the Fourth of July, a rocket launched high above California's Mojave Desert. This was no mere tardy display of patriotism; the rocket's launching team had been preparing for this moment for over four years. On July 10, Sir Richard Branson's space startup Virgin Orbit fired the rocket at an altitude of 35,000 feet from a modified airplane. The effort was a "drop test," meaning the rocket plunged to the earth rather than soaring into space, but for more reasons than this, it's considered groundbreaking.

"What a moment: [@virgin.orbit](#) have released our fully built, fully loaded LauncherOne rocket from Cosmic Girl for the first time," Branson [wrote on Instagram](#) just hours after the launch. "Congratulations to all the team."

Virgin Orbit's mission is to use the rocket to deploy small satellites into orbit. It will do so by launching not from the ground (as most rockets do), but from under the wing of Cosmic Girl, a modified Boeing 747-400 aircraft that is powered by four GE CF6 jet engines. The benefits of launching from a plane rather than a launch pad? It's cheaper, it provides more specific placement in orbit, and going by plane (rather than by ground-based launch systems) has shorter wait times.

“We hope to open access to space for companies or organizations who want to put small satellites into orbit by making launch affordable and flexible,” Kelly Latimer, Cosmic Girl’s chief pilot, told GE Reports in an email in 2018. “[We want] to open up space to more people.”



*It's a bird, it's a plane, it's a ... rocket launcher! Sir Richard Branson's space startup Virgin Orbit has successfully fired a rocket from Cosmic Girl, a modified airplane powered by four GE CF6 jet engines. Virgin Orbit plans to use the rocket to deploy small satellites into orbit. Above and top images credit: Virgin Orbit.*

Just after the launch, Latimer declared the endeavor to be a tremendous success. “The release was extremely smooth, and the rocket fell away nicely,” [she said](#). “Everything matched what we’d seen in the simulators well — in fact, the release dynamics and the aircraft handling qualities were both better than we expected. This was the best kind of test flight sortie from a test pilot’s perspective — an uneventful one.”

Cosmic Girl, which has undergone [significant refurbishing](#) in order to be capable of tucking a 70-foot rocket under its left wing, flew back to the runway after its first successful dummy launch to prepare for future flights. Now that the company knows the rocket can successfully detach from the plane, the Virgin Orbit team will continue work on an orbital test rocket that will fire satellites into space once it’s released rather than falling to the ground. No rest for the weary, Virgin Orbit CEO Dan Hart [told CNBC](#) prior to the test launch: The company plans to get its first paying customer’s satellites into orbit “hopefully ... before the end of the summer.”

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## SPACE FLIGHT

# She's Just A Cosmic Girl: This Virgin Orbit Souped-Up Jumbo Jet Will Give Satellites A Space Lift

Kristin Kloberdanz

December 08, 2018

Most rockets begin their journey to space from a launch pad that is firmly attached to the earth's surface. Virgin Orbit's LauncherOne is no ordinary rocket. Its mission is to deploy small satellites into space, and it does so by launching not from the ground, but from under the wing of Cosmic Girl, a modified Boeing 747-400 aircraft that is powered by four GE CF6 jet engines. "We hope to open access to space for companies or organizations who want to put small satellites into orbit by making launch affordable and flexible," Kelly Latimer, Cosmic Girl's chief pilot, told GE Reports in an email. "[We want] to open up space to more people." Last month, Cosmic Girl lifted a 70-foot rocket into the California sky. "It marks the first time a 747 has carried a rocket, let alone a space rocket, in its 70 year history and is a big step forward for the company as we look forward to reaching orbit in early 2019," Virgin Orbit wrote in a [blog](#).

A commercial space company formed in 2017, Virgin Orbit is part of Sir Richard Branson's constellation of businesses operating within the Virgin Group. It is seeking to hoist satellites to space by launching them from the air, rather than relying on busy terrestrial launch locations. Virgin

Orbit's CEO Dan Hart has said the company will be an alternative for launching most small satellites that weigh 300 to 500 kilograms [to low Earth orbit](#). These satellites, which provide GPS, phone and internet connections and other services, now ride to space on rockets. Virgin Orbit hopes to provide their operators with a "dedicated service" intended to place them not just anywhere in space, but in specific orbits. "Because Cosmic Girl can deploy the rocket from pretty much any latitude, it gives us better access to orbits that would otherwise be more difficult to reach," Virgin Orbit spokesperson Kendall Russell told GE Reports in an email.



*Top and above: In November, the GE-powered Cosmic Girl lifted a 70-foot rocket into the California sky. "It marks the first time a 747 has carried a rocket, let alone a space rocket, in its 70 year history and is a big step forward for the company as we look forward to reaching orbit in early 2019," Virgin Orbit wrote in a blog. Image credit: Virgin Orbit.*

He says Virgin Orbit's service is like riding a taxi rather than waiting for a bus. "A ride on [a larger rocket heading to space] might be slightly cheaper for a small satellite operator, but chances are your satellite won't be dropped off right where it needs to be, and your schedule is dependent on whoever else is sharing that ride with you, meaning you could be waiting for months to years," he says. "With a dedicated [small satellite] launch vehicle like LauncherOne, you control your own schedule and can get dropped off exactly where you need to be for your mission."

Virgin Orbit took over the satellite launch project from Virgin Galactic, a sister space tourism company developing spacecraft for suborbital flights. With an initial launch just ["months away,"](#) Virgin Orbit has already modified the 17-year-old Cosmic Girl plane from a passenger jet that was part of Virgin Atlantic's fleet into a mothership designed to lift LauncherOne to 35,000 feet. At that point, the expendable vehicle decouples from the plane and rockets off into orbit.

Virgin Orbit shaved about 65,000 pounds from Cosmic Girl. Gone are the seats, the Upper Class bar, the overhead luggage compartments and other jetliner features. Engineers also designed and built a custom mechanism called a launch pylon that hooks the LauncherOne rocket to the underside of Cosmic Girl's wing. "There was already a spot for a fifth engine carry between the number two engine and the fuselage," says Latimer, referring to the left wing engine closest to the body of the plane, "so we knew there had already been some analysis done by Boeing to hang a large object at that location."

The four jet engines powering Cosmic Girl have their own galactic pedigree, in a way. GE originally developed the engines for the C-5 Galaxy cargo planes used by the U.S. Air Force and later modified the engine for civilian flight. The design, called a [high-bypass turbofan](#) because it moves a large amount of air around the jet at the core of the engine to generate

thrust, allows it operate more efficiently than pure jets.

Today, virtually all civilian jets use this design, but back in 1965, the original engine, called TF39, was revolutionary. It allowed GE engineers to boost the engines' thrust to 40,000 pounds and cut fuel burn by a quarter compared with other engines in use at the time.



*The latest test flight took off from Victorville, California, where GE has its 747 flying test beds. Image credit: Virgin Orbit.*

GE quickly saw the commercial potential and built a passenger version of the TF39 called the CF6. It first flew in 1971, and over the years went through many design upgrades and iterations. Today, it is one of the most common jet engines in the world, powering all makes of planes, from Boeing 747 jumbos — including [Air Force One](#) — to Airbus long-haul jets and [Beluga cargo lifters](#). GE has delivered more than 7,000 of them to 250 airlines in 87 countries. The newest versions on the engine are expected to fly until 2040.

Russell says that among the reasons Virgin's Cosmic Girl was a perfect choice for their program were the Boeing 747's global supply chain and a long flight heritage. "Most airports are equipped to support the system, which is important for us as we emphasize quick and responsive flights to space — much like how airlines make money by keeping their planes flying as often as possible," he says.

The latest test flight took off from Victorville, California, where GE has its [747 flying test beds](#). Talk about birds of a feather flocking together!

#### CATEGORIES

[Aerospace](#)

#### TAGS

[Virgin Orbit](#)

[CF6](#)





## OSHKOSH

# Galaxy Quest: We Went Inside A Plane Large Enough To Carry A Tank Around The World

Tomas Kellner

July 27, 2016

The latest model of the gigantic C-5 Galaxy military transport jet galumphed into the Oshkosh fly-in on Tuesday. The plane, which was the world's largest aircraft when it first took off in 1968, helped launch GE's commercial aviation business.

The jet's first engines, called the TF39, used a design called a [high-bypass turbofan](#), which placed a big fan up front to generate thrust in combination with a jet. GE had to test the engines on a B-52 bomber, the closest plane in size to the gigantic C-5, which can lift 130 tons of cargo and has a range of 5,000 miles at 500 miles per hours.



*The C-5 jet is the largest transport plane in the Air Force fleet.*



*A pair of GE CF6 jet engines powering the latest generation of the C-5 Galaxy planes, the C-5M Super Galaxy.*

Today, virtually every mid-size and large commercial plane uses the same engine design, but back then, the TF39 was revolutionary. It allowed GE engineers to boost the engines' thrust to 40,000 pounds each and cut fuel burn by a quarter compared other engines in use at the time

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*When it flew for the first time in 1968, the C-5 Galaxy was the world's largest plane.*



*Thousands of people came to see the plane at Oshkosh on Tuesday.*

The plane that landed in Oshkosh—the C-5M Super Galaxy—was delivered to the Travis Air Force Base in California in 2014 and uses a military version of the CF6 engine. It allows the plane to use less runway and take off faster compared with the original TF39.

But jet engine evolution didn't stop with the CF6. GE engineers used their knowledge to build the GE90, the world's most powerful engine with thrusts of up to 127,500 pounds, the GEnx for the Boeing Dreamliner and 747-8 jumbo, and the GE9X, the world's largest engine developed for Boeing's next-generation 777X plane.

New materials such as carbon fiber composites for fan blades and fan cases, and modern designs cut weight by hundreds of pounds and boosted thrust. The latest engines like the GE9X and the LEAP, developed by CFM International—a joint venture between GE and France's Safran Aircraft Engines—even use 3D-printed parts and space-age ceramic composites. "Four decades from now, we could be printing an entire engine this way," said Michael Idelchik, former vice president for advanced technologies at GE Global Research, who was involved in the research.

While at Oshkosh, we took a close look at the Galaxy and its engines. Here's the haul.

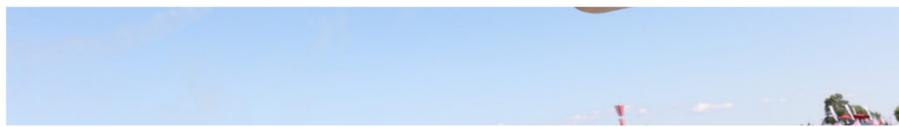


*The gigantic C-5 Galaxy military transport jet galumphed into the Oshkosh at noon on Tuesday. The plane distributes its weight over five sets of landing gear with 28 wheels.*



*The new engines produce more than 50,000 pounds of thrust each – a 22 percent increase over the TF39 engines on the first plane.*





The C-5M flew to Oshkosh from the Travis Air Force Base in California. According to Lockheed, the plane "has a 58 percent greater climb rate to an initial cruise altitude that is 38 percent higher than the current C-5. This capability delivers fuel savings greater than 20 percent compared to other airlifters."



The cargo hold of the C-5M. Loaded with 270,000 pounds (122,472 kilograms) of cargo, the plane can cover 2,150 nautical miles.



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