

Safe Flight for a 5G World

Global experts address potential effects

BY ED MUIR, BOEING WRITER

A global effort is underway to ensure that new 5G cellular technology can safely coexist with the operation of aircraft of all types — from the largest jumbo jets to the smallest civilian aircraft and everything in between.

Wireless network providers are rolling out 5G — the fifth-generation cellular network offering increased high-speed data — which uses a range of radio frequencies known as C-band. The global aviation industry has been analyzing the potential effects of 5G interference on radio altimeters, which also use the C-band and are on nearly every aircraft in the sky, including commercial, defense, regional, general aviation and helicopters.

Radio altimeters use radio wave signals to provide data about an aircraft's height above the ground, which is critical to many airplane systems and functions — automatic landing, flight controls, primary displays, crew alerting, surveillance and other systems, depending on airplane model. These differ from standard altimeters, which provide an aircraft's altitude above sea level by measuring atmospheric pressure.

In the U.S. and around the world, the 5G power limits authorized for cellphone towers can potentially interfere with radio altimeters on aircraft. As a result, regulators, telecommunications companies, radio altimeter manufacturers, airlines and aircraft manufacturers — including Boeing — have been working together to address the issue.

The U.S. Federal Aviation Administration (FAA) has taken a series of steps to protect aircraft operating in 5G environments, including issuing operational restrictions for aircraft and airports in areas where interference is possible. Work on interim measures continues, and the FAA recently proposed rulemaking that will require all aircraft to have an altimeter approved for 5G environments.

Altimeter Experts: Boeing Team Taps Into the Tech

Data from Boeing research and testing — in both labs and real flight tests — has helped inform regulatory agencies and others as they take steps to protect the safety of flight in 5G environments.

"Advancements in wireless technologies are continuing," said Howard McKenzie, Boeing chief engineer and executive vice president of Engineering, Test & Technology. "While industry, regulators and airlines are rigorously partnering to address the introduction of 5G towers in proximity with airport operations now, we're also focused on applying what we learn here to get ready for future developments."

Here are just a few of the many Boeing teammates around the world providing expertise in this new future:



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**HOWARD MCKENZIE,
CHIEF ENGINEER AND
EXECUTIVE VICE PRESIDENT
OF ENGINEERING,
TEST & TECHNOLOGY**



BEN IVERS
Autonomous Systems Director
PHOTO: BOEING



JENNIFER HOLDER
Regulatory Affairs Director
PHOTO: BOEING



MATT HARRIS
Systems Engineer
PHOTO: PAUL PINNER/BOEING

BEN IVERS co-leads Boeing's 5G radio altimeter response team with the FAA that collaborates with regulators, the telecommunications industry, suppliers and other key aviation stakeholders around the world.

With an extensive technical background in airplane avionics, he understands how technologies like radio altimeters and other complex systems are integrated on an airplane. His experience working on different Boeing products and with industry partners has been essential to Boeing's approach to finding technical, regulatory and operational 5G solutions.

"When we first learned there was a 5G safety concern, it wasn't hard to find the right people at Boeing. In the middle of the pandemic, the vast majority of our work was completed remotely around the world, including Australia, Europe and the U.S. — across all time zones. Collaboration was the glue that kept us together."

JENNIFER HOLDER co-leads the 5G radio altimeter response team with the FAA, focusing on finding safety solutions that mitigate potential effects of 5G interference. She helped bring together Boeing experts in various disciplines in order to conduct technical analysis and risk assessment.

Previously, she worked extensively on the 737 MAX where she led effects analysis with an emphasis on resource systems, like radio altimeters, that provide flight-critical data to the flight control and auto-throttle systems as well as to the flight crew. The team's 5G research has helped the industry better understand the issue and propose potential solutions.

"Our job is aviation safety, and we take that very seriously. Our team mobilized hundreds of people to pull together the data and information to ensure the safety of those flying on our airplanes."

MATT HARRIS, a Boeing Technical Fellow, specializes in radio navigation systems and has been working on 5G testing and data collection for more than two years.

With deep knowledge of radio frequency systems and integration, Harris led an enterprisewide technical team tasked with collecting and interpreting data from 5G and radar altimeter testing.

Harris provided key technical inputs to an industry team that developed an alternative method of compliance (AMOC) methodology. The AMOC methodology allowed the FAA to check each airplane's altimeter installation against each active 5G base station for compatibility, allowing most airplanes to continue without operational restrictions while assuring continued safety.

"Aviation is making progress on developing new standards with our partners at the FAA, the FCC (Federal Communications Commission) and in the telecommunications industry," said Harris. "We know this is an important issue, and Boeing teams will continue to work toward the safe and efficient solutions needed now and into the future."

JOE CRAMER leads Boeing's 5G radio altimeter response team, collaborating with the FCC, the telecommunications industry and its regulators, suppliers and other stakeholders around the world. His background as both a mechanical engineer and lawyer specializing in spectrum management enables him to understand both sides of the situation – from the effects 5G signals have on airplanes to the regulatory and radio frequency spectrum issues at hand.

As someone who understands the regulatory and technical nuances of 5G's potential effects on airplanes, he can translate that knowledge to those regulators who are not engineers. He also works with international telecommunications and aviation regulators and even the United Nations on telecommunications issues.

"So much has changed in this area in recent years, but we will get to a solution that ensures safe travel for the flying public," Cramer said.

TIFFANY PETTIT led the 5G airplane-level effects analysis for Boeing. With her expertise in flight controls and those systems that consume radar altimeter data, she was able to assess the potential 5G effects on sensor behavior.

That information helped regulators in their efforts to ensure the continued operational safety of aircraft flying in 5G environments.

As an expert in autoflight design, safety and certification, Pettit also led the detailed hazard and risk assessment process for all Boeing commercial airplane models.

"Innovation has driven significant advances in airplane systems performance and safety across the Boeing fleet. However, the more that sensors are leveraged to extend capability, the more vital an accurate understanding of our operational environment is," Pettit said. "5G is a reminder that environments can and do change. Thankfully, our 5G team showed that collaboration with our regulators, industry groups and standards communities can allow innovation to progress without compromising safety."



JOE CRAMER
Regulatory Affairs Director
PHOTO: BOEING



TIFFANY PETTIT
Flight Controls Engineer
PHOTO: BOEING



MATT SUNDAY
Avionics Engineering
Senior Manager
PHOTO: BOEING

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**JOE CRAMER,
REGULATORY AFFAIRS
DIRECTOR**

MATT SUNDAY co-leads a team working to develop, manufacture, certify and deploy hardware to limit 5G interference on Boeing products. His experience in avionics development, test and manufacturing, and certification methods has been critical in this fast-moving environment.

"Once industry and regulators identified a path forward for near-term equipment needs in the fleet, the broader Boeing team jumped right in," Sunday said. "We've worked with Supply Chain, Engineering, Customer Support, Boeing Research & Technology and others to face the challenge head-on."

"We've helped lead the industry to ensure the continued safety of our products."



DATA ON DECK
Jennifer Henderson (left), Commercial Airplanes Production chief pilot, and Kevin Zeznick, flight test pilot, configure the airplane for test conditions.

PHOTO: BOEING



FLY BY

A 737-7 passes above Ogden, Utah, near a 5G signal to determine how an airplane might respond.

PHOTO: GARY STUCK/BOEING



TAXI TO TEST

A 737-7 heads toward the runway at Boeing Field in Seattle.

PHOTO: BOEING



UP AND RUNNING

A 5G cellular communications tower for mobile phone and video data transmission.

PHOTO: BILL OXFORD/GETTY



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FLIGHT CONTROLS ENGINEER**

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**MATT SUNDAY,
AVIONICS ENGINEERING
SENIOR MANAGER**



TRAY TABLE TESTING

Josh McCormick (left), from the Flight Test Engineering Analysis team, and Chan Luy, a navigation systems engineer, collect and monitor real-time data during a flight test.

PHOTO: BOEING



TOWER POWER

A mobile telephone tower base station emits a 5G signal to aid testing, as a 737 (not pictured) flies nearby.

PHOTO: GARY STUCK/BOEING