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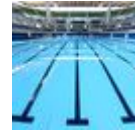
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INVESTIGATIONS

We tested popular cellphones for radiofrequency radiation. Now the FCC is investigating.

By SAM ROE
CHICAGO TRIBUNE | AUG 21, 2019





The Apple iPhone 7 was set to operate at full power and secured below a tub of clear liquid, specially formulated to simulate human tissue.

With the push of a button, a robotic arm swung into action, sending a pencil-thin probe dipping into the tub. For 18 minutes, it repeatedly measured the amount of radiofrequency radiation the liquid was absorbing from the cellphone.

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This test, which was paid for by the Tribune and conducted according to federal guidelines at an accredited lab, produced a surprising result: Radiofrequency radiation exposure from the iPhone 7 — one of the most popular smartphones ever sold — measured over the legal safety limit and more than double what Apple reported to federal regulators from its own testing.

The Federal Communications Commission, which is responsible for regulating phones, states on its website that if a cellphone has been approved for sale, the device “will never exceed” the maximum allowable exposure limit. But this phone, in an independent lab inspection, had done exactly that.

[Testing cellphones for radiofrequency radiation: How we did it »](#)

The Tribune tested three more brand-new iPhone 7s at full power, and these phones also measured over the exposure limit. In all, 11 models from four companies were tested, with varying results.

The Tribune’s testing, though limited, represents one of the most comprehensive independent investigations of its kind, and the results raise questions about whether cellphones always meet safety standards set up to protect the public.

After reviewing the lab reports from the Tribune’s tests, the FCC said it would take the rare step of conducting its own testing over the next couple of months.

“We take seriously any claims on non-compliance with the RF (radiofrequency) exposure standards and will be obtaining and testing the subject phones for compliance with FCC rules,” agency spokesman Neil Grace said.

New cellphones are charged and prepped before being tested for radiofrequency radiation last year at the RF Exposure Lab in San Marcos, Calif. (Brian Cassella / Chicago Tribune)

The Tribune set out a year ago to explore an important question: Are cellphones as safe as manufacturers and government regulators say?

Though it's unclear whether radiofrequency radiation from cellphones can increase cancer risk or lead to other harm, that question is increasingly pressing given the widespread use of cellphones today. Many children and teenagers may face years of exposure.

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The newspaper's testing was not meant to rank phone models for safety – only 11 models were examined, and in most cases just one device was tested. Nor is it possible to know whether any of the cellphones that tested above limits could cause harm. Two of the phone manufacturers, including Apple, disputed the Tribune's results, saying the lab used by the newspaper had not tested the phones the same

results, saying the lab used by the newspaper had not tested the phones the same way they do.

But the results of the Tribune's investigation contribute to an ongoing debate about the possible risks posed by radiofrequency radiation from cellphones, and they offer evidence that existing federal standards may not be adequate to protect the public.

The results

The Tribune tested 11 cellphone models by measuring how much radiofrequency radiation was absorbed by a simulated body positioned near the phone. The Federal Communications Commission has set an exposure limit of 1.6 watts per kilogram averaged over one gram of tissue.

How the tests were performed

Standard test: The phones were tested in accordance with FCC rules and guidelines. Exposure was measured at two distances from the simulated body: the distance the manufacturers chose for their own premarket testing (5, 10 or 15 millimeters) and a closer "pocket test" at 2 millimeters.

Modified test: The Apple and Motorola phones were retested after those companies provided feedback based on the results. These tests added steps intended to activate sensors designed to reduce the phones' power. Two newly acquired phones also underwent the modified tests.

See testing results

Industry officials and manufacturers emphasize that before a new model can be brought to market, a sample phone must be tested and comply with an exposure standard for radiofrequency radiation. But manufacturers are allowed to select the testing lab — and only a single phone needs to pass in order for millions of others to be sold.

Companies testing a new phone for compliance with the safety limit also are permitted to position the phone up to 25 millimeters away from the body — nearly an inch — depending on how the device is used. That’s because the testing

standards were adopted in the 1990s, when people frequently carried cellphones on belt clips.

In one phase of the Tribune testing, all phones were positioned at the same distance from the simulated body tissue that the manufacturers chose for their own tests — from 5 to 15 millimeters, depending on the model. Apple, for instance, tests at 5 millimeters.

But people now often carry phones closer to the body, in their pockets, which increases their potential exposure to radiofrequency radiation.

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To assess this kind of exposure, the Tribune asked its lab to conduct a second phase of testing, placing the phones 2 millimeters away from the simulated body — closer than any of the manufacturers' own tests and far less than the maximum distance allowed by the FCC.

Jay Moulton, owner of RF Exposure Lab, places a cellphone in position for testing. (Brian Cassella / Chicago Tribune)

The 2-millimeter distance was chosen to estimate the potential exposure for an owner carrying the phone in a pants or shirt pocket. Under those conditions, most of the models tested yielded results that were over the exposure limit, sometimes far exceeding it.

At 2 millimeters, the results from a Samsung Galaxy S8 were more than five times the standard.

The Government Accountability Office, Congress' research arm, recommended in 2012 that the FCC reassess the exposure limit and its testing requirements, saying that because phones weren't measured while against the body, authorities could not ensure exposures were under the standard.

Seven years later — after a lengthy period of public comment — the FCC came to its conclusion. The agency announced this month that the existing standard sufficiently protects the public and should remain in place.

Few other government officials have acted in recent years to address the possible risks of radiofrequency radiation from cellphones. But in California, the state Public Health Department in 2017 issued rare guidance on how concerned consumers could reduce exposure.

Among the advice: Don't carry cellphones in pockets.

A man relaxes outside Wrigley Field earlier this year. Federal rules don't require cellphones to be positioned against the body when they are tested for radiofrequency radiation. (Erin Hooley / Chicago Tribune)

Apple, Samsung respond

When informed of the Tribune's test results and provided with the laboratory's 100-page lab report, Apple disputed the findings, saying they were not performed in a way that properly assesses iPhones.

The Tribune's tests were conducted by RF Exposure Lab, a facility in San Marcos, Calif., that is recognized by the FCC as accredited to test for radiofrequency radiation from electronic devices. For 15 years, the lab has done radiation testing for wireless companies seeking government approval for new products.

Lab owner Jay Moulton said all the Tribune's tests were done in accordance with detailed FCC rules and guidelines.

"We're not doing anything extraordinary or different here," Moulton said. Any qualified lab "should be able to grab a phone off the shelf and test it to see if it meets requirements."

An Apple iPhone is tested at RF Exposure Lab in October 2018. The company disputed the results of the Tribune testing, which led to more tests in March. (Brian Cassella / Chicago Tribune)

Apple, one of the world's most iconic brands, would not say specifically what it thought was wrong with the Tribune's tests or reveal how the company measures its phones for potential radiofrequency radiation exposure.

Still, based on Apple's feedback, the Tribune retested the iPhones in the investigation as well as an additional iPhone 7, making a change aimed at activating sensors that would reduce power.

Once again, the iPhone 7s produced results over the safety limit, while an iPhone 8 that previously measured over the standard came in under.

When informed of the new results, Apple officials declined to be interviewed and requested the Tribune put its questions in writing. The newspaper did, submitting three dozen, but Apple did not answer any of them.

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Apple then issued a statement, repeating that the Tribune test results for the iPhone 7s “were inaccurate due to the test setup not being in accordance with procedures necessary to properly assess the iPhone models.”

“All iPhone models, including iPhone 7, are fully certified by the FCC and in every other country where iPhone is sold,” the statement said. “After careful review and subsequent validation of all iPhone models tested in the (Tribune) report, we confirmed we are in compliance and meet all applicable ... exposure guidelines and limits.”

Apple did not explain what it meant by “careful review and subsequent validation.”

Jay Moulton records results as a cellphone is tested for radiofrequency radiation. (Brian Cassella / Chicago Tribune)

The three Samsung phones tested by the Tribune — the Galaxy S8, Galaxy S9 and Galaxy J3 — were positioned at 10 or 15 millimeters from the body, the distances chosen by the company in accordance with FCC guidelines. In these tests, the devices measured under the safety limit.

But when the phones were tested at 2 millimeters from the simulated body — to represent a device being used while in a pocket — the exposures measured well over the standard.

Samsung, based in South Korea and one of the world's top smartphone makers, said in a statement: "Samsung devices sold in the United States comply with FCC regulations. Our devices are tested according to the same test protocols that are used across the industry."

FCC officials would not comment on individual results from phones tested by the Tribune. They said that although the Tribune testing was not as comprehensive as what would be required for an official compliance report, they would examine some of the phone models in the newspaper's investigation.

Assessing the risk

Around-the-clock cellphone use represents one of the most dramatic cultural shifts in decades. In 2009, an estimated 50 million smartphones were in active use in America, according to the wireless industry association CTIA. Today, there are 285 million. Twenty-nine percent of U.S. teens sleep with their cellphones in bed with them, according to a 2016 report by the nonprofit organization Common Sense

them, according to a 2019 report by the nonprofit organization Common Sense Media.

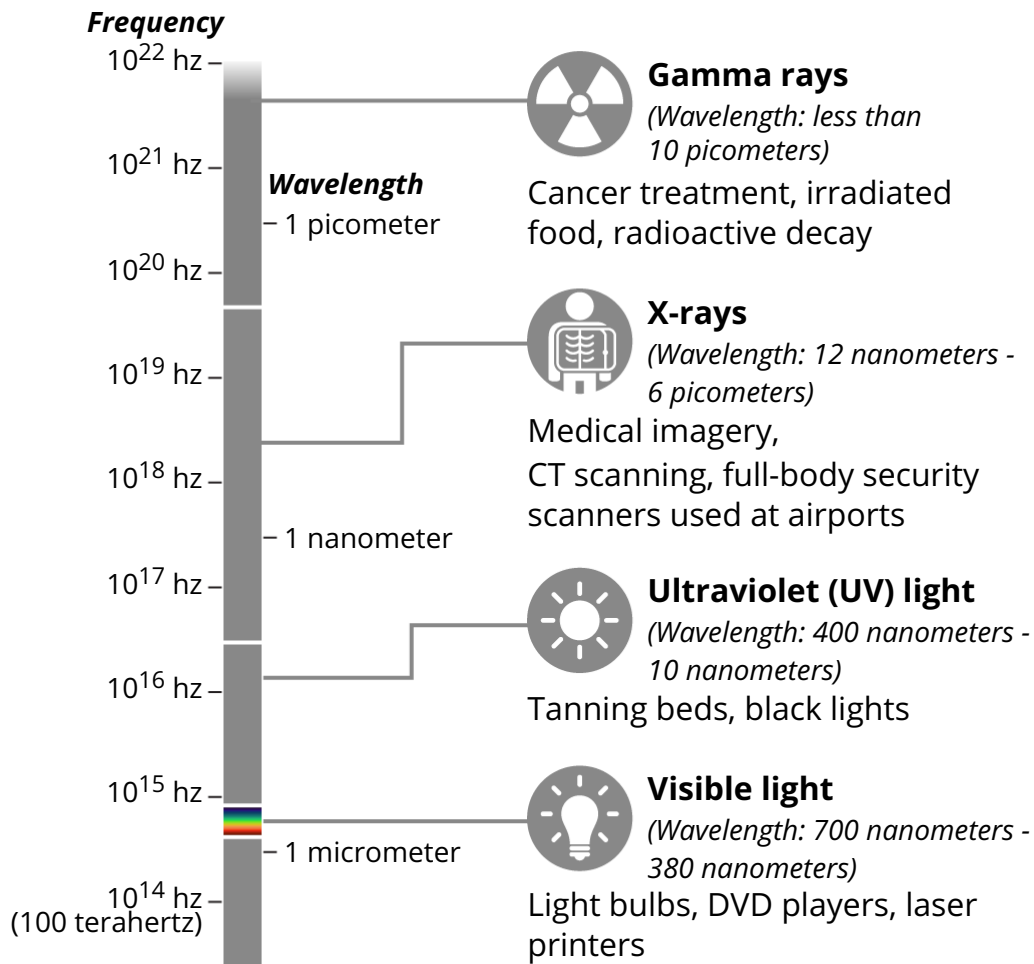
Some researchers say safety efforts have not kept pace. "These days," said Om Gandhi, an early researcher of cellphone radiation at the University of Utah, "exposure is from cradle to grave."

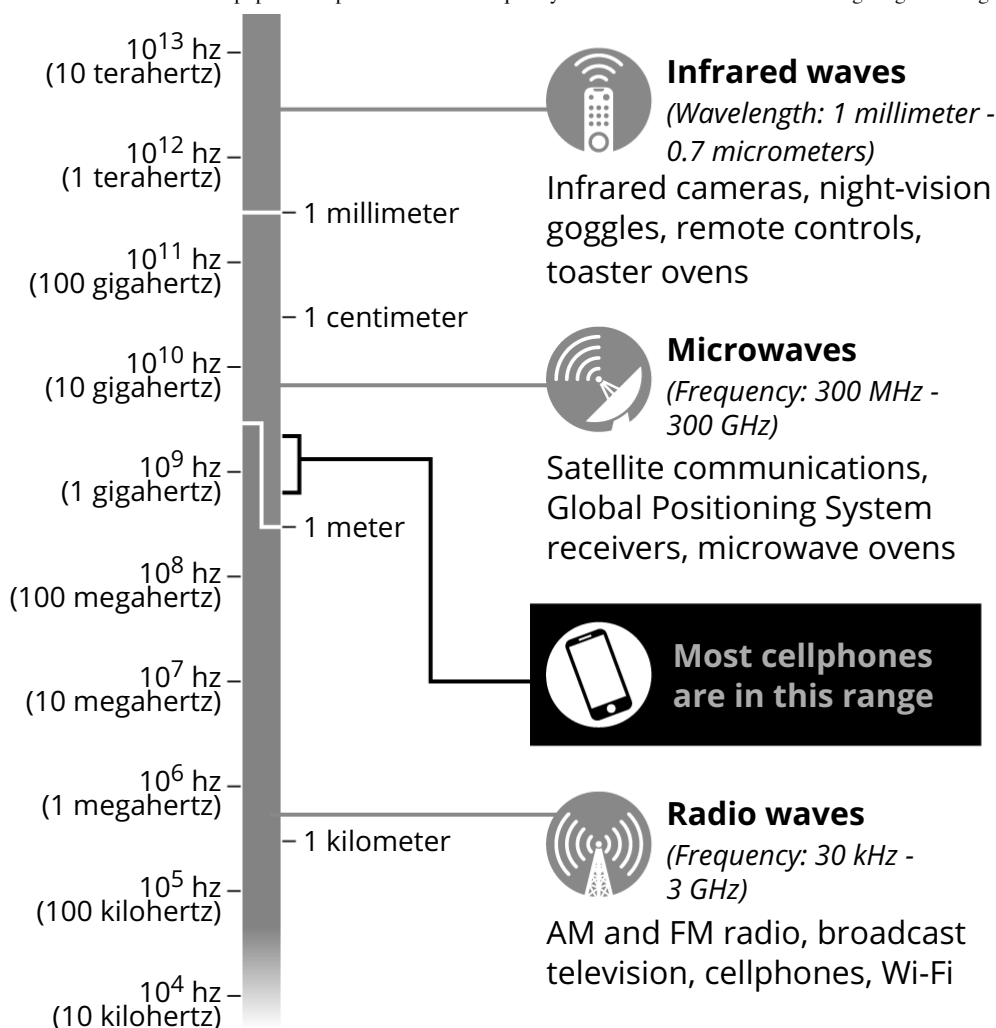
Cellphones use radio waves to communicate with a vast network of fixed installations called base stations or cell towers. These radio waves are a form of electromagnetic radiation, in the same frequency range used by TVs and microwave ovens.

How cellphone radiation compares with other types

Different kinds of electromagnetic radiation travel at different frequencies and wavelengths. At one end of the spectrum, gamma rays and X-rays have known health effects. Cellphones rely on radio waves, and the potential for harm from long-term exposure is less certain. Here are the types of electromagnetic radiation and some common technological uses:

THE ELECTROMAGNETIC SPECTRUM *Displayed on a logarithmic scale*





SOURCES: National Aeronautics and Space Administration, Encyclopaedia Britannica, Chicago Tribune reporting

This kind of radiation, also known as radiofrequency energy, shouldn't be confused with ionizing radiation, such as gamma rays and X-rays, which can strip electrons from atoms and cause serious biological harm, including cancer.

Radiofrequency energy from cellphones isn't powerful enough to cause ionization, but at high levels it can heat biological tissue and cause harm. Eyes and testes are especially vulnerable because they do not dispel heat rapidly.

Less understood is whether people, especially children, are at risk for other health effects, including cancer, from exposure to low-level cellphone radiation over many years — potentially decades.

When cellphones hit the market in the 1980s, authorities focused on setting an exposure limit to address only the heating risks of cellphones. Scientists found that

~~EXPOSURE LIMIT TO ADDRESS ONLY THE HEATING RISKS OF CELLPHONES. SCIENTISTS FOUND THAT~~
animals showed adverse effects when exposed to enough radiofrequency radiation to raise their body temperature by 1 degree Celsius. Authorities used this finding to help calculate a safety limit for humans, building in a 50-fold safety factor.

The final rule, adopted by the FCC in 1996, stated that cellphone users cannot potentially absorb more than 1.6 watts per kilogram averaged over one gram of tissue. To demonstrate compliance, phone makers were told to conduct two tests: when the devices were held against the head and when held up to an inch from the body.

A woman uses a cellphone at Lollapalooza this summer. New phone models must be tested for radiofrequency radiation before coming to market. (Camille Fine / Chicago Tribune)

These testing methods didn't address the anatomy of children and that of other vulnerable populations, such as pregnant women, said Joel Moskowitz, a cellphone expert at the University of California at Berkeley.

"It was like one-size-fits-all." Plus, he said, "I don't think anyone anticipated the smartphone and how it would become so integral to our lives."

The devices became ubiquitous and were increasingly slipped into pockets rather than carried on belt clips. The number of scientific studies related to cellphone radiofrequency radiation soared.

Last fall, in one of the largest studies to date, the National Toxicology Program, a research group within the U.S. Department of Health and Human Services, found that high exposure to the kind of radiofrequency radiation used by cellphones was associated with "clear evidence" of cancerous heart tumors in male rats.

The U.S. Food and Drug Administration, which shares regulatory responsibilities for cellphones with the FCC, responded to the study by assuring the public there was no danger to humans at "exposures at or under" safety limits. But the Tribune's testing, disputed by manufacturers, found results from some cellphones over the exposure standard, particularly when tested close to the body.

Despite the changing ways people use phones, both the FCC and FDA said the current exposure limit protects the public. The agencies cite the 50-fold safety margin incorporated into the standard, as does CTIA, the industry association

margin incorporated into the standard, as does C11A, the industry association.

Over the limit

A half-hour drive north of San Diego, in the city of San Marcos, is RF Exposure Lab, a low-slung beige and white building that has the look and layout of a dentist's office. Down the main hallway, past several doors, is a room with dozens of large containers labeled "Head Tissue" and "Body Tissue."

Moulton, the lab owner, recalled how an intern once spilled some "body tissue" on himself and "freaked out because he thought it was real human tissue." But it was just a mixture of mostly water, sugar and salt that simulates the electrical properties of the body. The liquid is used frequently at the lab, one of the few facilities in the U.S. that is accredited to test phones and other devices for radiofrequency radiation.

Different liquid mixtures are used to simulate the electrical properties of human tissue in radiofrequency radiation testing at RF Exposure Lab. (Brian Cassella / Chicago Tribune)

Moulton founded the lab in 2004 after serving as engineering director for chip-making giant Qualcomm. There, he said, he often wrestled with the radiation issue while helping design phones for Verizon.

The Tribune hired Moulton to conduct tests on 11 different models of cellphones, all purchased new by the newspaper. The tests took place in a 10-foot-by-10-foot room outfitted with copper screen windows to reduce electrical interference. In the

middle of the room was a “phantom body,” an oval-shaped tub the size of a kitchen sink. Inside the tub was a body tissue mixture.

Moulton carefully positioned the first phone to be tested — an Apple iPhone 8 — under the phantom body so that it was 5 millimeters from the outside of the tub. This separation distance was the same gap selected by Apple in its tests and was in accordance with federal guidelines.

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Using a base station simulator outside the room, Moulton placed a call to the iPhone 8 and adjusted the settings so the device was operating in the same band, frequency and channel that yielded the highest radiofrequency radiation reading reported by Apple to the FCC during the regulatory approval process — data that is available on the agency website.

The phone was now operating at full power, creating what was essentially a worst-case scenario in terms of radiofrequency radiation exposure. Typically, Moulton said, consumers do not experience exposure like this. But it could happen, he said, in limited situations, such as someone talking continuously in an area with a weak connection.

Jay Moulton preps equipment for cellphone testing at RF Exposure Lab. (Brian Cassella / Chicago Tribune)

A probe attached to a robotic arm moved up and down, and back and forth, in the fluid, taking 276 measurements of the radiation absorbed. After a few minutes, the probe stopped, and the results appeared on a nearby computer screen: The radiofrequency radiation level for the iPhone 8 measured 2.64 W/kg — more than double the highest value Apple reported to the FCC and well over the 1.6 safety limit.

Moulton said he was surprised. “Maybe the phone’s power sensor isn’t working,” he said. “It’s supposed to be on.”

Almost all smartphones, he said, have power sensors — also known as proximity sensors — designed to detect when the device is touching or extremely close to a person. When that occurs, the phone is supposed to reduce power, decreasing radiofrequency radiation.

“Let’s see how this iPhone 7 does,” he said, picking up the next phone to be tested. He secured it 5 millimeters under the phantom body, placed a call to the phone and activated the probe.

Minutes later, the results were in: 2.81 W/kg, again over the limit. He tested another iPhone 7, getting a similar result: 2.50 W/kg.

“Still high,” Moulton said.

A probe attached to a robotic arm measures how much radiofrequency radiation from a cellphone is being absorbed by the simulated body tissue. (Brian Cassella / Chicago Tribune)

As more phones were tested, some results came in low. For instance, Samsung's Galaxy S9, S8 and J3 phones measured under the standard.

But the lab had tested the Samsung phones relatively far away from the simulated body, because that's how the manufacturer had tested the devices when seeking FCC approval.

Two Samsung phones were tested at 10 millimeters away and one at 15 millimeters — still within federal guidelines but much greater than the 5-millimeter gap chosen by Apple for its tests.

So how would the Samsung devices and other models fare when tested at a consistent distance, one even closer to the body?

The 'pocket test'

To help answer this question, the Tribune cut out pieces of dress shirts, T-shirts, jeans, track pants and underwear and sent them to Moulton. His measurements indicated that phones carried in pants or shirt pockets typically would be no more than 2 millimeters from the body.

Moulton then conducted the same radiation tests, using the same methods and equipment. The only difference was that the phones were placed 2 millimeters from the phantom body — closer than any of the manufacturers' own tests and much closer than the maximum distance allowed by the FCC

~~MUCH CLOSER THAN THE MAXIMUM DISTANCE ALLOWED BY THE FCC.~~

Maybe, he said, the phones' proximity sensors would kick in at this closer distance, and the radiofrequency radiation levels would drop accordingly.

But most phones still showed high levels. The four iPhone 7s tested at 2 millimeters produced results twice the safety standard. The iPhone 8 measured three times over; the Moto e5 Play from Motorola measured quadruple the standard.

And the Samsung Galaxy phones?

All three measured at more than twice the standard, with the Galaxy S8 registering 8.22 W/kg — five times the standard and the highest exposure level seen in any of the Tribune tests.

Only two phones came in under the standard in the 2-millimeter "pocket test": an iPhone 8 Plus and a BLU Vivo 5 Mini.

Moulton said he couldn't be certain why any of the phones in the Tribune tests scored as they did.

Only the manufacturers, he said, could say for sure.

A visitor to Millennium Park in Chicago talks on a cellphone. "I don't think anyone anticipated the smartphone and how it would become so integral to our lives," said California cellphone expert Joel Moskowitz. (Antonio Perez / Chicago Tribune)

Seeking an explanation

Apple and Motorola disputed the Tribune's testing protocol but declined to answer written questions.

Motorola officials did say one thing about the high exposure measurement for their Moto e5 Play, which came in nearly three times the safety limit in a 5-millimeter test at the Tribune lab: They speculated the test did not trigger the proximity sensors in that phone.

Though the Tribune's lab had followed all FCC testing methods, the newspaper subsequently retested the Moto e5 Play, slightly altering the previous testing method to reflect Motorola's input. The Tribune also retested a Moto g6 Play, which had scored right at the safety limit in the first test, as well as an additional model, a Moto e5.

When tested with these modified methods, the exposure results for all three phones were under the limit at the 5-millimeter distance.

Moulton said the two test results for the e5 Play indicate that its sensors may not

~~MOTOROLA SAID THE TWO TEST RESULTS FOR THE CT 1 DAY INDICATE THAT ITS SENSORS MAY NOT~~
work under certain conditions.

Motorola, which is based in Chicago, said in a statement that “all Motorola devices meet or exceed FCC requirements” but would not answer questions about its power sensors.

“Our power management techniques and expertise provide Motorola with a significant competitive advantage in the marketplace, and are therefore highly confidential,” the company’s statement said. “The Chicago Tribune’s third-party lab was not privy to the proprietary techniques from Motorola necessary to elicit accurate results.”

Rules set by the FCC require that radiofrequency radiation testing be done “in a manner that permits independent assessment.”

Motorola said that after receiving the Tribune’s test results, it had the models in question tested at its outside lab, which “found results were within the appropriate limits.” When the Tribune asked Motorola to explain how it tests its phones, the company declined. It also would not share its lab reports.

The Tribune also retested several iPhones based on Apple’s feedback. A reporter touched or grasped the phones for the duration of the tests, actions intended to activate sensors that are designed to reduce the devices’ power.

Tribune reporter Sam Roe grasps an iPhone during retesting at RF Exposure Lab in March. Apple had disputed the results of earlier tests, saying they were not conducted in a way that properly assesses iPhones. (Sam Roe / Chicago Tribune)

In these tests, the iPhone 8 measured under the limit at 5 millimeters, but all four iPhone 7s did not.

In response to these results, Apple issued a statement saying the lab procedures in the Tribune testing still were improper. The company, based in Cupertino, Calif., wouldn't say what methods were necessary.

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FCC documents show that when Apple sought agency approval in 2016 to market the iPhone 7, the company promised to “take appropriate action” on any complaint “relating to the product’s compliance with requirements of the relevant standard.”

Apple, which said it validated the safety of its phones in response to the Tribune testing, would not provide any additional detail about the actions it took to evaluate the phones.

The company also wouldn’t comment on the information it provides the public on radiofrequency radiation. Consumers can find such information on their iPhones, but it’s difficult.

On the iPhone 7, for instance, a user would go to Settings > General > About > Legal > RF Exposure. There, the term “radiofrequency radiation” is not used but rather “RF energy,” a reference to radiofrequency exposure.

Around-the-clock cellphone use represents one of the most dramatic cultural changes in decades. (Erin Hooley / Chicago Tribune)

To reduce exposure, Apple suggests using “a hands-free option, such as the built-in speakerphone, the supplied headphones, or other similar accessories.”

For some past models, Apple gives additional advice. Apple’s website tells users of the iPhone 4 and 4s: “Carry iPhone at least 10mm away from your body to ensure exposure levels remain at or below the as-tested levels.” The site says those phones were tested at a distance of 10 millimeters.

When Apple submitted its application to the FCC to market the iPhone 7, the company included a similarly worded radiation statement, suggesting users carry the device at least 5 millimeters from the body, records show.

But iPhone 7s eventually sold to the public did not include that advice.

When the Tribune asked Apple in its written questions why that suggestion was not included, the company did not respond.

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Sam Roe



We tested popular cellphones for radiofrequency radiation. Now the FCC is investigating. - Chicago Tribune
Sam Koe is an investigative reporter for the Chicago Tribune who writes about various topics. He was part of the reporting team that won the 2008 Pulitzer Prize for investigative reporting, and he was a Pulitzer finalist four other times. He also teaches at Columbia College Chicago and coaches baseball in Oak Park.

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Chicago Tribune



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