UIET PLACES

Designed to stop the reflection of sound or electromagnetic waves, anechoic chambers are essential to today's consumer electronics testing. CET&D surveys some of the most silent spaces on Earth.

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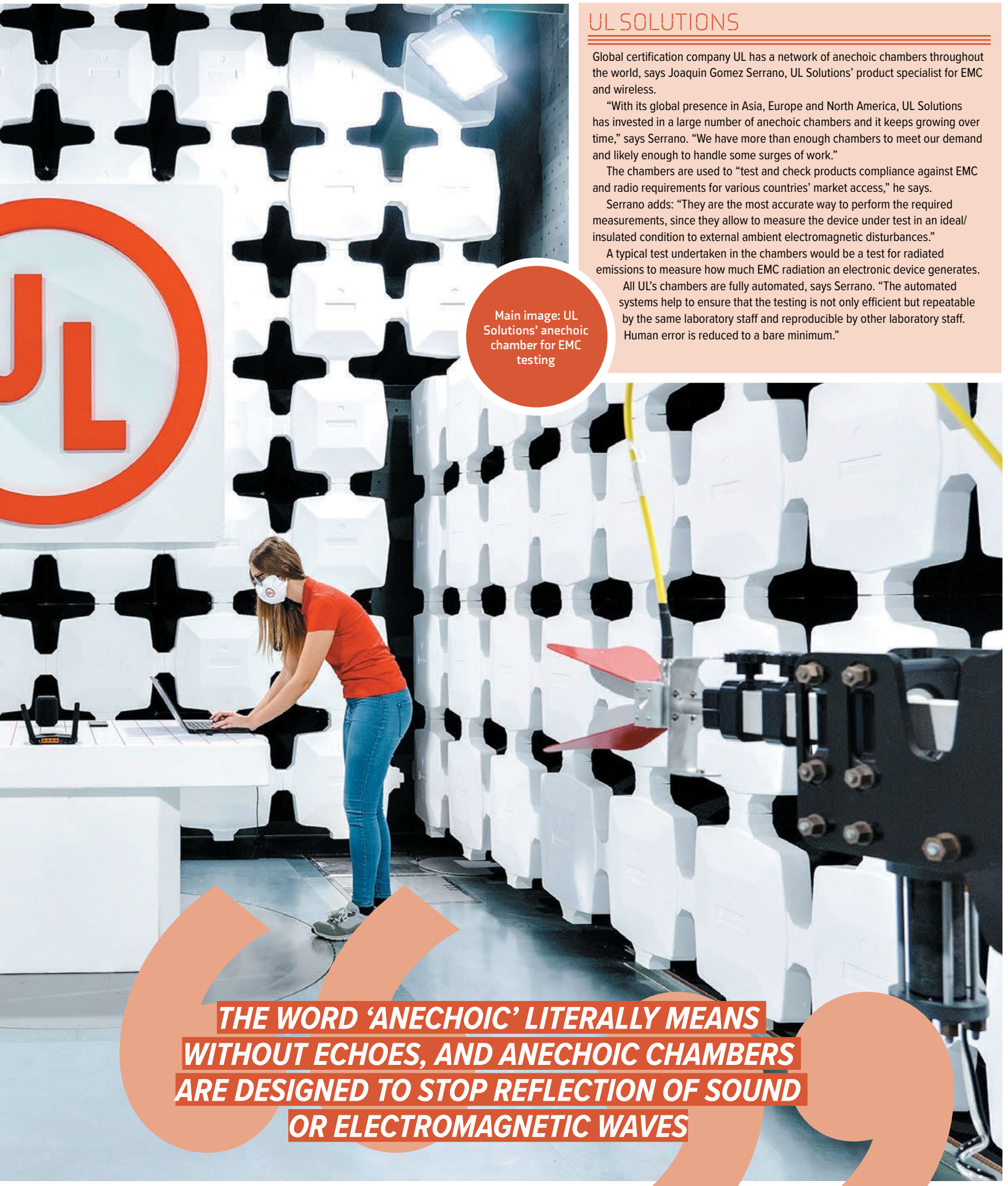
Tucked away in the Minneapolis suburbs is a venue once reputed by the Guinness World Records to be "the quietest place on Earth."

The venue is an anechoic chamber owned and operated by Orfield Labs, a multi-sensory design research laboratory. The chamber is so quiet, says owner and president Steve Orfield, that they were once able to capture "the sound of a pin dropping one foot onto carpet."

The word 'anechoic' literally means without echoes, and anechoic chambers are designed to stop reflection of sound or electromagnetic waves. In the field of consumer electronics, they are used for audio testing and for electromagnetic compatibility (EMC) testing.

Orfield Labs' anechoic chamber is only used for acoustic testing. The chamber is accredited by the US National Institute for Standards and Technology (NIST). In order to maintain this accreditation the lab is audited every two years to ensure its calibrations have not deviated.



Main image: UL Solutions' anechoic chamber for EMC testing

UL SOLUTIONS

Global certification company UL has a network of anechoic chambers throughout the world, says Joaquin Gomez Serrano, UL Solutions' product specialist for EMC and wireless.

"With its global presence in Asia, Europe and North America, UL Solutions has invested in a large number of anechoic chambers and it keeps growing over time," says Serrano. "We have more than enough chambers to meet our demand and likely enough to handle some surges of work."

The chambers are used to "test and check products compliance against EMC and radio requirements for various countries' market access," he says.

Serrano adds: "They are the most accurate way to perform the required measurements, since they allow to measure the device under test in an ideal/insulated condition to external ambient electromagnetic disturbances."

A typical test undertaken in the chambers would be a test for radiated emissions to measure how much EMC radiation an electronic device generates.

All UL's chambers are fully automated, says Serrano. "The automated systems help to ensure that the testing is not only efficient but repeatable by the same laboratory staff and reproducible by other laboratory staff. Human error is reduced to a bare minimum."

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Above left and right: Steve Orfield and his record-breaking anechoic chamber

The idea being, says Orfield, that if you are running tests in "a government-accredited lab anywhere in the world, you should be within half a decibel of the same test at anywhere else."

NOT LIKE THE REAL WORLD

"These rooms aren't intended to be like anything you experience in the real world," he adds. "They're intended to be an exact test environment that can be replicated."

While Orfield's anechoic chamber lost its Guiness World Record to Microsoft's anechoic chamber in Redmond, Washington, in 2015, it remains the only accredited publicly-available anechoic chamber in the US, says Orfield.

As such, he says, its services are in high demand. Among other things, the chamber has been used to test smartphones, headsets, loudspeakers, televisions, and large and small appliances. "Anything you could imagine we've measured because anybody who needs an anechoic chamber comes to us," he says.

Orfield Lab's accreditation allows them to carry out certification testing for a number of international standards, including ISO, ASTM and IEC.

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STEVE ORFIELD, ORFIELD LABS OWNER

Contrary to what you might think, quietness is not the most important quality of an anechoic chamber. "What we're known for around the world – our quietness – has nothing to do with the requirements of an anechoic chamber," says Orfield. "It's simply that the quieter your chamber is, the quieter the products you can measure."

ABSORBENCY IS THE KEY

Actually, what matter most in an anechoic chamber is absorbency. The walls of the chambers are composed of a series of wedges that are shaped in such a way as to absorb the maximum amount of soundwaves.

Orfield contrasts how anechoic chambers work with reverberation chambers, which are also used for acoustic testing. "In a reverberation chamber the sound echoes and diffuses and doesn't get absorbed," says Orfield. "So the characteristic that defines a reverberation chamber is that it is perfectly diffuse, meaning the sound everywhere is the same."

A typical acoustic product test that might be run in either an anechoic chamber or a reverberation chamber is a test for sound power. To run this test, typically a hemispherical array of microphones are placed all around the product.

However, because sound levels are diffuse in reverberation chambers, by running the test there it is impossible to know how sound levels might differ depending on your orientation to the product.

"In the anechoic chamber there are 10 mics and each mic picks up a different sound," says Orfield. "So if you want to know things like the directionality of a product; if you want to know

NASA

NASA has a long history of using anechoic chambers, says Randolph Cabell, flight acoustics team lead at NASA's Langley research center in Hampton, Virginia.

"Although some of these facilities are more than 50 years old, they have all been modified or enhanced over the past few decades to adapt to the changing needs of the aerospace industry," says Cabell.

However, says Cabell, a facility that has remained unchanged since its original construction is the small anechoic chamber at Langley, which was constructed in 1974.

There is one other anechoic on the Langley campus – called the small hover anechoic chamber. Elsewhere at Langley there are a number of other acoustic testing facilitates that while not dedicated anechoic chambers, nonetheless have "walls, floors, and ceilings that have been treated to some degree with an acoustically absorptive material to minimize reflected sound," he says.

They include: the quiet flow facility, the low speed aero-acoustic wind tunnel, and the structural acoustic loads and transmission facility.

NASA's long-term use of anechoic chambers is testimony to the essential role of acoustic testing in aerospace development, says Cabell.

"Aerospace technologies often have acoustic design objectives that are tightly coupled with other design objectives such as aerodynamic or engine performance," he says. "Therefore, many facilities include capabilities to measure, sometimes simultaneously, acoustic and performance parameters."

Some examples of NASA-developed technologies where anechoic chambers played a role in the development include: chevrons for jet noise reduction; quiet propeller designs; high-lift noise reduction devices and landing gear noise reduction concepts; and fuselage structures that reduce sound transmission.

NASA also has anechoic chambers "that are specifically designed for electromagnetic testing," says Cabell, "for example, to measure the performance of antennas used to transmit information from distant spacecraft."

While most testing in NASA's anechoic chambers is to support in-house projects, there are some exceptions made.

Cabell says: "Outside organizations are allowed to test in NASA facilities on a fee for service basis if the test requires a capability that is unique to a NASA facility not available in a commercial acoustical testing lab, and if that work is complementary to work being performed in NASA programs and projects."

Left and inset: Product testing in Gore's anechoic chamber

GORE

Global material science company Gore has a number of anechoic test boxes and small chambers "to support a variety of Gore acoustic tests," says Chad Banter, a Gore acoustics application engineer.

The company also has one fully anechoic chamber built by the reputed anechoic chamber maker Eckel Industries. This chamber is used in the development of Gore's acoustic membrane products, such as the protective vents that cover various mobile device's microphones and speakers.

"Gore has been performing acoustic tests using anechoic test environments for over 20 years and more recently purchased the fully anechoic chamber to expand our measurement capability," says Banter.

Most of Gore's anechoic test facilities are at its center in Elkton, Maryland, but it also has acoustic test capabilities in China and Japan, says Banter. The full anechoic chamber allows "for true free field tests down to 160Hz whereas the smaller anechoic box is a pressure field environment."

Banter notes: "These pressure field environments can be challenging given the critical need for accurate spatial positioning of the device-under-test (DUT) along with the random wave behavior of any near field source speaker or stimulus."

Banter describes a typical setup to test one of the company's acoustic membranes.

"A typical test in the chamber to evaluate Gore Acoustic Vents would involve a stimulus or speaker, a reference microphone and a DUT microphone," says Banter. "All these transducers (speaker and microphones) would be located toward the center of the chamber (also known as 'the sweet spot') to avoid potential reflections at the wall boundary.

"The reference microphone and DUT microphone would be positioned very close in proximity to each other to ensure similar acoustic pressure is measured at both locations from the speaker. The speaker would then be calibrated using the reference microphone to ensure proper drive level is achieved at the co-located microphone position."

"Once the calibration is complete, the DUT microphone could be evaluated both with and without various Gore Acoustic Vents to determine their overall acoustic performance impact on the microphone's performance."

anechoic chambers used for EMC testing often resemble acoustic anechoic chambers.

However, unlike acoustic chambers, the interior surfaces of the RF anechoic chambers are covered with radiation-absorbent material, most commonly a foam absorber made from fireproofed urethane foam loaded with conductive carbon black.

The highly specialized materials needed to make them and the careful craft that goes into their construction means that acquiring an anechoic chamber is a significant investment.

Orfield Lab's anechoic chamber has a long and storied history. It was built by Eckel Industries, which was founded in the early 1950s and is credited with building the world's first anechoic a decade. "In 1995 we built an acoustic addition to our current building, and that's when we were able to assemble the chamber," says Orfield.

Ensuring the maximum quietness possible is not only about the design of the chamber, says Orfield. The location is also an important factor.

"We're in a quiet location next to a park in a quiet business park five miles out of downtown Minneapolis," he says. "There are no train stations or airports nearby and the nearest freeway is a mile away."

A CHAMBER WITHIN A CHAMBER

To enhance the quietness even further, Orfield Labs' chamber actually consists of two chambers, an inner and an outer one. The inner chamber sits on steel I-beams that are suspended on springs over a pit. There are no rigid materials connecting the inner and outer chamber, meaning that sound vibrations in the outer chamber cannot penetrate to the inner chamber.

Furthermore, the building surrounding the two chambers is made of 12-inch thick concrete. The result is a space so unerringly quiet that those who experience it for a prolonged period of time frequently become disoriented and have to leave.

A quiet bedroom at night measures about 30 decibels; Orfield Labs, by contrast, recently recorded a measure of -24 decibels in the chamber; a new world record for quietness if it is confirmed by Guinness World Records.

The achievement of such extraordinary levels of sound-proofing without the budget of a multinational corporation speaks to Orfield's lifelong obsession with sound. His interest in sound began in childhood, he says.

"When I was a kid I was a tune-up mechanic at gas stations," he says. Determined to make his tune-ups as precise as possible he began bringing in his own testing tools. He got so good at his job that local race car drivers would seek him out.

"While my friends were making $2 an hour for bagging groceries, I was making $30 an hour for doing the precision tuning on cars."

One realization he had during his time working on cars, which has served him in his product testing, was about the relationship between sound and a product's longevity.

"One of the things you find out when you deal with sound quality is the better and smoother something sounds, the longer it's going to last," says Orfield. "Because noise is friction." **CET&D**

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