Create Healthy Homes
Environmental Design and Inspection Services

Oram Miller, BBEC, EMRS
Certified Building Biology® Environmental Consultant
Electromagnetic Radiation Specialist
11693 San Vicente Blvd., #342
Los Angeles, California 90049

Phone 310.720.7686
info@createhealthyhomes.com
www.createhealthyhomes.com

Synopsis of 5G Article by Oram Miller on www.createhealthyhomes.com

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This is a synopsis of material presented in an article on 5G Cellular Technology that I wrote on my website, createhealthyhomes.com. The direct link to the article is https://createhealthyhomes.com/five_g.php .

This Synopsis was written independently of my website's 5G article. This synopsis as written below does not appear on my website's 5G article, although portions of it are taken from that website. It essentially encapsulates the information in that article.

My updated 5G website article includes a new two-page Brief Summary as well as Summary Points. The article also presents new Summary Tables that provide useful information on the 4G LTE and 5G services provided by each cellular carrier in the US at each band (low, mid and high/mmWave) and how they differ by characteristics. I also provide links to 5G coverage maps for each of the four major cell carriers in the US.

Where This Information on 5G Is Available

Besides my own 5G article on my website, at https://createhealthyhomes.com/five_g.php, I have written about this topic in an article available on the Building Biology Institute website as a paid online course, entitled, "5G: Understanding The Technology & Protection Strategies", available at https://buildingbiologyinstitute.org/course/electromagnetic-radiation/5g-cellular-phone-systems/. A three-page fact sheet available on that same page is free and can be distributed.

How I Obtained This Information

Most of this information was obtained from a 5G trade show that I attended here in Los Angeles this past two Octobers (2018 and 2019). I listened to lectures and attended booths sponsored by cell antenna manufacturers and several cell carriers. The conferences were attended by 22,000 engineers and others in the 5G industry. It was very interesting to see this issue from their perspective.

I learned an incredible amount of detailed knowledge and took copious notes. I have also learned a great deal from industry publications. Much of that information is presented in articles I have written, the one for the Institute and the other on my own website. I have also explained this information in several interviews. Links to those interviews that are currently available are found in the 5G article on my website, linked to above.

5G Has Three Parts

In essence, the confusion that exists about 5G is that it actually has three parts. The first and second are in what is called the low (600 MHz to 1-2 GHz) and mid (1-2 GHz to 6 GHz) bands, or as they are also known, sub-6 GHz 5G.

The third part is in the high or millimeter wave (mmWave) band beginning at roughly 20 GHz and going up to several hundred GHz. That is also known as the super-20 GHz band. (In the US, no cell service will exist between 6-20 GHz for the foreseeable future.) This mmWave band above 20 GHz is what most people associate with the term 5G.

There is much confusion as to what 5G means in these three bands, the two in the sub-6 GHz band and the one in the super-20 GHz or mmWave band. The characteristics of cell signal transmissions within these three bands depends upon the physics of each band, meaning its frequencies, wavelengths and the modulation involved with shaping the signals.

Multiple Input, Multiple Output (MIMO) Used with 4G and 5G

Since mmWave signals above 20 GHz have short wavelengths, they cannot pass through normal building materials. Signals therefore need to be beam-formed in order to get through walls. That is where *massive* Multiple Input, Multiple Output, or MIMO, comes in.

Right now, existing 4G LTE macro cell antennas use 2T2R (two transmit, two receive) arrays on each 4G LTE antenna. That defines the maximum number of signals they can transmit in any direction, with about ten or so mobile cell customers served per array. Cell carriers are upgrading existing 4G equipment that have had 2T2R antennas with 4X4 antennas, also known as 4T4R (four transmit, four receive), in what is known as "LTE Advanced" technology. That doubles the amount of signals in a given air space.

Cell antennas in the high, mmWave band, on the other hand, must use multiple small antennas arrayed in a square or rectangle, up to 8 or more across and 8 or more high.

That allows 64 or more antennas to simultaneously send signals that can be shaped electronically, using phased array, to send the combined signal from all 64 of them in one direction or another. This process is called beam-forming or beam-steering. AI (artificial intelligence) in the radio beneath (or embedded within) the antenna directs the whole process. Multiple signals can be sent out at once to multiple handheld user devices, which would be 5G-enabled cell phones. This is the only way that 5G cell signals in the mmWave band can penetrate walls and windows, and not very well at that.

Beam-forming using Massive MIMO can also be used down to 2 GHz. Thus, Sprint uses this technology for its mid band 2.5 GHz 5G service. As explained below, Sprint is able to devote 32 antennas of the 64 transmitting antenna array to 4G and the other 32 to 5G, or with a software change, all 64 can be used for 5G. This is all at the 2.5 MHz frequency. What differentiates the 4G from the 5G signal? The amount of modulation and pulsing that occurs in creating and shaping the cell signal (although both upgraded 4G and 5G radios and antennas are now heavily modulated). Modulation and pulsing of cell signals, as you will see below, have a significant impact on our health and are a great concern to 5G activists and advocates whatever the frequency band being used.

Existing 4G LTE macro cell antennas broadcast at power levels up to 1,000 Watts Effective Radiated Power (ERP), which can travel up to several miles (and farther). Therefore, 4G LTE macro cell antennas are spaced about 1 to 1.5 miles apart. About 300,000 of them currently exist in the US.

4G LTE macro cell antennas are about three feet tall and skinny, about ten inches wide, as shown on the right. You see them mounted on buildings and poles, pointed in various directions. Each slender antenna contains 4 or 16 antennas inside, which are larger than new 5G antennas because the wavelength of existing sub-6 GHz 4G LTE signals is 4-15 inches in length. 4G antennas can also be smaller, roughly 2 feet tall, shown below on the right.

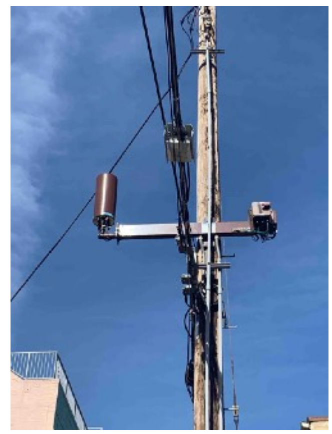
Small Cell Arrays Will Have 4G/5G Hybrid Antennas

New small cell antennas, on the other hand, will be located in neighborhoods between existing 4G LTE macro towers, most prominently in dense urban and suburban areas, although low and mid band small cell antennas will also be placed in and around towns in rural areas. They will transmit at 10 or 100 Watts ERP, not 1,000 Watts like existing 4G LTE antennas. Small cell antennas will use both 4G LTE and 5G technology.

New 4G small cell antennas are often placed on top of a pole and have a cylindrical cover, as seen in the photos to the right. They can also have the two-foot high shape seen on the previous page.

All of these 4G and 5G antennas will broadcast in the low and mid bands. These include the nationwide rollout of T-Mobile's 600 MHz 5G service and AT&T's 850 MHz "5G Evolution" service, both in the low band, to large parts of the US.

Sprint is also rolling out their 2.5 GHz mid band "True Mobile" 5G service in large areas of nine cities throughout the US.



5G service in the high/mmWave band above 20 GHz is also provided by T-Mobile in much more limited service in six cities. AT&T provides mmWave "5G+" service in limited areas of 25 cities, but only to business customers. You need a different 5G phone from T-Mobile and AT&T to access these mmWave signals than you do to connect to their low band 5G nationwide network.

Verizon has almost of all of its 5G presence in the mmWave band at 28 and 39 GHz, with a smaller amount of coverage in the upper mid band at 5.2 GHz. You will see a Verizon mmWave 5G antenna lower down on the pole in the third photo down on the right. See more photos of 5G massive MIMO antennas on the next page.

All four carriers will be bidding for new mid band spectrum being made available at auction by the FCC at 3.5 and 3.7-4.2 GHz this year (2020).

See my website 5G article for more information about what each cell carrier is doing at each frequency and links to coverage maps on each carrier's website.

It is important for everyone to understand that the majority of new small cell antennas will have upgraded 4G service, using what is called LTE-Advanced technology. This includes 4X4 antennas, carrier aggregation, License Assisted Access (LAA), LTE-Machine Type Communication (LTE-M), Narrowband Internet of Things (NB-IoT), and 256 QAM.

All of these technologies increase data download speeds and the number of cell signals and information broadcast in the same airspace, but at the same strength as before. All new 4G antennas will have the capacity to be upgraded to 5G through software changes, but what kind of 5G that means depends upon the frequency band the 4G antenna is broadcasting in. 4G is only in the low and mid bands, so any upgrade to 5G would not involve beam-forming unless it was broadcasting above 2 GHz in the mid band.

New 4G LTE-Advanced and 5G cell signals are far more modulated than past generations of cell technology. They utilize polarized, pulsed signaling. This modulation and pulsed signaling may account for recent increases in health symptoms in residents living near new small cell antennas. Reports are emerging that certain individuals are reacting to new cell antennas, while they did not react to existing 4G LTE technology used for years.

This is important in our consideration of how one can protect oneself, as you will see.

How mmWave 5G Signals Get Through Walls

Massive MIMO, to be used as part of 5G technology, involves new 64T64R (and more) antennas. This means eight by eight antenna arrays totaling 64 or more in number that transmit and receive, all packed into a rectangular antenna about the size of a pizza box. Each of the 64 antennas is smaller than the 4 or 16 antennas on 4G towers because the wavelength for mm wave 5G signals is less than one inch in size (only a few millimeters). Examples are shown at right.

4G and 5G small cell antennas that are beam-formed use artificial intelligence to shape the way the beams travel out from all 64 antennas at once. This allows the antennas to send a beam of data in a particular direction with highly focused energy, as has been discussed by many in our community. 4G and 5G arrays that use beam-forming can send signals to multiple cell phones at once, or if only one subscriber is in front of them, that 5G-enabled phone will get all four signals. That would be highly focused energy for the person holding that phone.

mmWave 5G Signals Are On-Demand and Narrow

One important distinction to understand between 4G LTE and 5G technology is that 5G signals in the high mmWave band are sent on-demand. This is misunderstood by many who think 5G beam-formed signals in the mmWave are always-on. Instead, those signals only transmit when a 5G-enabled device calls for a connection. Then the 5G signal is sent out in a narrow beam using beam-forming technology. Otherwise, the mmWave 5G small cell antenna is dormant (except for a weak, intermittent reference signal—see below). 5G small cell antennas using the mmWave band will therefore not be sweeping the neighborhood with strong, focused beam-formed signals, as many think.

4G LTE and Low Band 5G Signals Are Always-on, Wide and Strong

4G LTE and low band 5G signals, on the other hand, *do* bathe a neighborhood with strong, always-on RF energy at widths of 120 degrees. They are every bit the culprit as 5G signals in the mmWave band are in this story and they are the bulk of new small cell antennas being deployed in neighborhoods in the U.S. and around the world.

I was told by engineers at the 5G industry conference that a beam-formed 5G signal is sliced into ten or twelve narrow beams, each roughly 10 degrees wide. Since the signal is broadcast at up to 10-100 Watts, it does not go as far as a macro 4G signal at 1,000 Watts. The industry says small cell signals at 10 to 100 Watts travel roughly 1-1.5 blocks, however Verizon has logged 1+ Gbps download speeds at 28 GHz at half a mile. Newer beam-formed 4G and 5G signals can cover up to one square mile.

4G LTE and low band 5G signals from small cell antennas, on the other hand, are, as I have said, always-on regardless of the power density, whether 10 or 100 Watts, as on new small cell antennas, or 1,000 Watts, as on existing macro cell towers.

Small cell antennas with 4G LTE and low band 5G transmitters would therefore send out a constant RF signal that is 120 degrees wide and shaped like a cone. Even though it would be transmitting at 10-100 Watts, the 4G LTE or low band 5G signal from one of those small cell antennas could be as close as 30-100 feet from your house at the second story level. I discuss below the very high RF levels that have been measured in second story bedrooms from these 4G LTE/low band 5G signals.

Measuring and Shielding 4G and Low to Mid Band 5G Cell Signals

One of the only benefits of this debacle of having always-on 4G and low to mid band 5G cell signals so close to people's homes is that at least we can measure their signal with every RF meter/detector we have available to us. This is because they use low and mid band sub-6 GHz frequencies, all of which we can measure with our RF meters. I have links to the RF meters that I recommend in my 5G article, at https://createhealthyhomes.com/five_g.php.

Since most 5G will be in the low to mid bands, along with more modulated and more harmful 4G LTE-Advanced signals also in the low to mid bands, RF-shielding materials available to us now will shield signals in these bands. These materials include paint, building foil, RF-shielding fabrics and film, mesh screen and fabric for windows. They are available in North America from Safe Living Technologies (http://www.slt.co), LessEMF (https://www.lessemf.com), Electrahealth (https://www.electrahealth.com/) and other retailers.

In the super-20 GHz mmWave band, 5G signals will also be able to be blocked by solid RF-shielding materials like two layers of paint or foil. Also, Aaronia has a silver fabric that appears to block signals in those mmWave frequencies (https://www.aaronia.com/

Datasheets/Screening/Shielding_fabric_Aaronia_Shield_50dB.pdf), but all other fabrics nor metal mesh screen won't do as well. The RF-shielding pattern of fabrics is on a downward path on the graph as you approach 18 GHz, which is as high as we can measure with current equipment, and it goes down from there. 5G signals in the mmWave band are at 28 and 39 GHz and higher. See https://www.slt.co/Downloads/Shared/All_Fabrics_Shielding_Line_Graph.pdf.

How Does 5G Work in Low and Mid Band Frequencies?

As to the question about what exactly is considered to be 5G in the low and mid bands below 6 GHz, I asked that question of antenna manufacturers at the 5G industry conference I attended. I knew that beam-forming can be used down to 2 GHz, which is in the mid band, involving massive MIMO (up to 64Transmit, 64 Receive antennas), but I asked them about the new 600 MHz signals that T-Mobile is also touting as 5G. Antenna manufacturers make radios and antennas that can transmit both 4G and 5G at 600 MHz for T-Mobile. They demonstrated at their booth how much signal was being emitted using 4G technology and how much used 5G technology on spectrum analyzers.

Their answer was that 5G in the low and mid bands involves more modulation of the signal to make it faster, with lower latency, and to have more signals sent out in the same airspace. This is not massive MIMO and not beam-forming, not below 2 GHz. Engineers use advanced technologies such as: 4Transmit, 4Recieve (4T4R or 4X4) antennas rather than previous 2X2 antennas, thus doubling the number of cell transmissions in a given airspace; carrier aggregation; License Assisted Access (LAA); LTE-Machine Type Communication (LTE-M),; Narrowband Internet of Things (NB-IoT); and 256 QAM, or quadrature amplitude modulation (higher than before).

Quadrature amplitude modulation has to do with how the signal is shaped and transmitted. It determines how much information can be sent in a given airspace and at what speed. Up until now, carriers have used less than 256 QAM. This new use of 256 QAM is an improvement over previous generations of the technology.

It is important to know that these same new modulating technologies are also being incorporated into upgraded 4G equipment in what is being called LTE-Advanced technology.

The net result of all of these new 4G and 5G technologies is faster download speeds and lower latency using existing low and mid band frequencies below 6 GHz. Latency is the time it takes for signals to reach their destination and for a response to return to the sending device. This determines how real-life the sending and processing of data becomes. Latency has an impact upon the realism of virtual reality and the reliability of self-driving cars, if they are ever deployed, and other tasks.

As these cell signals increase in modulation, they also increase the potential harm to biological life in their path. Please refer to the scientific evidence and medical research posted on the website for the Environmental Health Trust, at https://ehtrust.org/key-issues/cell-phoneswireless/5g-internet-everything/, among other websites posted at the end of my 5G article, https://createhealthyhomes.com/five_g.php.

Relatively Slower Download Speeds in Low to Mid Bands vs. Faster Download Speeds in mmWave Band

In practical terms, what the manufacturer's reps told me and what I learned in lectures and industry articles was that 5G in the low to mid sub-6 GHz band would essentially be what they call, "enhanced 4G LTE" or "5G-lite". Right now, 4G LTE is capable of delivering about 20-30 Megabits per second on average, or Mbps of data download speed. That is what we are all used to now when downloading or streaming data and videos.

5G in the low to mid sub-6 GHz band will be increased to about 200-300 Mbps, on average. That's it. That is what T-Mobile is advertising now with the recent rollout of their new 600 MHz nationwide 5G network. Their claim is that they have the jump on their competition because they are using their existing 600 MHz 4G LTE network, which has been enhanced on their new 5G network with advanced technologies to send more data at the same frequencies as their 4G LTE network uses now. Signals at 600 MHz have the longest wavelength of any cell signals in the US. 600 MHz is the lowest frequency used by any cell carrier in the U.S. but it has the longest wavelength, about 15 inches or so. That signal penetrates building walls very easily and travels the farthest. You need a new 5G-enabled phone to receive T-Mobile's low band 5G signal.

AT&T has also rolled out their nationwide 5G network at 850 MHz, which is also in the low band. Again, download speeds will be in the low hundreds of Mbps, likewise essentially making it enhanced 4G. However, like T-Mobile's 5G network at 600 MHz, AT&T's 5G network at 850 MHz will travel far and pass deep into buildings.

Both T-Mobile and AT&T also have 5G spectrum in the mmWave band. In addition, T-Mobile and Sprint are hoping to merge, expanding their networks to one large network using low, mid and high/mmWave band frequencies. That merger is close to completion.

Cell signals in the mmWave band, on the other hand, which is where everyone in our community thinks 5G only exists, will be able to transmit data at never before seen speeds of 1,000 to 3,000 Megabits per second (Mbps) or 1-3 Gigabits per second (Gbps). That is up to one hundred times faster than we currently have. That means downloading videos at what many feel will be super fast speeds with much lower latency. However, those signals don't go very far and they are easily blocked. That is why industry has resisted for so long to use frequencies above 20 GHz. They also come at an increased risk of harm to all biological life.

Specifically, mmWave frequencies have a very short wavelength, only a few millimeters or a half an inch long. They only travel a relatively short distance and cannot easily pass through walls. Even rain, moisture and air molecules easily block mmWave signals.

Satellite TV companies have used these mmWave frequencies above 20 GHz for decades. If you put a satellite dish inside your attic, under your roof, you cannot receive a signal. That signal, broadcast in the same mmWave band now sought for 5G use by cell carriers, does not pass through standard shingles and plywood found on any roof today. The dish has to be on top of the roof, not under the roof in the attic, in open view of the southern sky (where the satellite is parked in geo-stationary earth orbit) with no trees in the way. Otherwise, the roof and tree leaves will easily block the signal.

5G Small Cell Antennas Will Transmit a Weak Reference Signal

I learned at the 5G industry conference that small cell mmWave 5G antennas send out what industry calls a reference signal looking for a 5G-enabled device. Those bursts last 10 or 20 milliseconds and occur a few times a minute. To conserve power, the reference signal is reportedly very weak, designed to be 1% of the power or strength of RF signals when data is being sent.

To determine how strong that reference signal actually was, we measured the reference signal from 5G antennas at the conference center using equipment at two booths on the recent trade show floor. We used $35,000 to $60,000 spectrum analyzers to measure 28 GHz 5G signals coming from antennas in the rafters of the Los Angeles Convention Center. Those antennas were not part of the show. They have been installed by a particular cell company for attendees of all the trade shows at the Convention Center who are also customers of theirs to use. We measured the 28 GHz reference signals at power densities of -60 to -70 dBm, or decibels per meter.

When you compare that -60 to -70 dBm signal to the unit of measurement we are used to using, it is equal to 0.1 to 0.01 microWatts/meter squared. You can see that equivalence by clicking here and scrolling down on the chart to -60 dBm and then scrolling over to the column for uW/m2 (microWatts/meter squared).

In the case of an actual beam-formed mid or high mmWave band 5G antenna, that -60 to -70 dBm would be the strength of a 5G reference signal that you would measure outside a house coming from a 5G small cell antenna located in front of the house. Again, that would be equivalent to 0.1 to 0.01 microWatts/meter squared of RF exposure.

The walls and window glass of your house would then block that weak RF signal from entering the house. Granted, no one wants to have any RF coming to their house from any source, but a signal that weak and at that wavelength would not penetrate walls very well. That 0.1 to 0.01 microWatt signal would also be considerably overshadowed by RF signals coming from distant 4G LTE cell towers within a mile or so of most homes. I routinely measure at least 5-20 microWatts/meter squared, and often substantially more, of RF signals when standing in front of almost every urban and suburban home I evaluate in my EMF practice here in Southern California. Those 4G signals have a much longer wavelength and do penetrate the walls and windows of every house. You have to be out in the country, far away from people and therefore, far from 4G cell towers, to avoid nearby 4G LTE towers found in every urban and suburban neighborhood for the past several decades.

In fact, in most homes that I evaluate, I also routinely measure 20-150 microWatts/meter squared of RF in second story bedrooms, where neighbor's houses don't block the signals coming in from nearby 4G LTE macro cell towers. How do I know that these RF signals are from 4G cell towers and not entirely from routers in my client's home or neighbor's homes? By the high-pitched squealing sound that I have learned to associate with 4G cell towers.

I have seen and heard this on my Gigahertz Solutions HF59B RF meter (and now also on my Safe & Sound Pro II RF meter) for years. You can hear these RF sounds for yourself by listening to audio Wave files of RF sounds on the website for Safe Living Technologies under their Education tab, and then by clickin on EMF Sounds. You can access that page on their website by clicking here. The sound of WiFi from my client's router or a neighbors router is sometimes mixed in, but the strength of the WiFi signals, especially from the neighbor, drops off significantly with distance and it is much weaker, one-half a Watt, compared to the strength of a distant 4G macro cell tower transmitting at up to 1,000 Watts.

That is the environment in which we live in any city or town in America with four networks overlayed in every neighborhood from four cell carriers. That is before small cell antennas of any kind are added to the mix. We already have a toxic soup of 4G LTE signals right now. Fifth generation (5G) cell technology to be implemented over the coming decade will add many more 4G LTE and 5G small cell antennas to our neighborhoods, especially in dense cities, if they are not stopped through citizen efforts.

I certainly don't want to be misunderstood here. I am in no way saying 5G antennas in front of people's houses are safe. I am merely pointing out that the bigger danger, in my opinion, is from low and mid band 4G and 5G small cell antennas for all the reasons given above. Just be sure not to use a 5G-enabled phone in your own home if you live near a city's downtown and have a mmWave 5G antenna in front of your house. If you do, or if someone else in your house does, you or they will bring that beam-formed 5G signal into your home when you are using your phone. Otherwise, it won't come in.

However, the low and mid band 4G LTE-Advanced and 5G signals certainly will pass through your walls and windows if you are unlucky enough to have one of those small cell antennas in front of your house. I have already personally measured them and the RF levels are high. All of this needs to be opposed in terms of deployment of any antennas in residential neighborhoods and avoiding RF and other EMF sources in your own home.

5G-enabled Cell Phones Must Be Stationary to Receive 5G Signals

Beam-formed 5G signals in the mmWave band are best received when a 5G-enabled cell phone is stationary inside someone's house. When the phone is moved around, one of several scenarios will happen: the 5G beam-formed signal will either be passed from one zone to another coming from the 5G antenna, or it will be passed back to a nearby 4G LTE tower, or it will be passed off to the person's indoor Wi-Fi network. In either of the latter two options, data will once again flow at slower speeds. (Dynamic 5G, whereby the 5G small cell antenna can track and stay connected to the 5G-enabled phone as it is moved around, is not yet possible, but engineers expect that to happen within a few years.)

The fast 5G data download speed therefore primarily happens when the 5G-enabled phone is kept in one place. Journalists for Wired magazine lost the 5G mmWave signal and were switched back to slower 4G when they walked into stores when testing 5G mmWave data downloads in test cities. They only received the fast 5G signal when outside on the city sidewalk.

Also, 5G-enabled cell phones do not currently send data back on 5G mmWave frequencies, according to engineers with whom I spoke. The phone uses 4G LTE frequencies and protocols when sending data back to a 5G tower. That, too, will change soon.

Alasdair Phillips (https://emfields-solutions.com) wrote a very succinct piece recently saying that 5G in the mmWave band will primarily be deployed in dense urban areas. It is not considered by industry as a carrier or blanket network because it does not go as far nor does it penetrate building materials as sub-6 GHz signals do.

What to Pay Attention to in Neighborhoods

I say, what you really don't want is a 4G or low or mid band 5G small cell antenna in front of your house. This is because these antenna will be always-on, transmitting radio frequency cell signals 24/7 into your house with a signal that is 120 degrees wide. Again, even if the transmitted power is only 10 to 100 Watts and not 1,000 Watts as sent by existing 4G cell tower a mile away, the new 4G LTE-Advanced and low and mid band 5G small cell antennas in front of your house will be only 30-100 feet away with always-on cell signals.

Colleagues have measured up to 400,000 microWatts/meter squared of RF power flux density with their Gigahertz Solutions HF59B RF meter in second story bedrooms. (You can also measure this well with an Acoustimeter RF meter (http://www.aitsafe.com/go.htm?go=www.lessemf.com/rf.html&afid=51307&tm=90&im=#139)—measuring in peak, not average—as well as the new Safe and Sound Pro II RF Detector from Safe Living Technologies, available at https://slt.co/Products/RFMeters/SafeandSoundProIIRFMeter.aspx).

Remember, if you can measure an RF signal coming from any small cell antenna with your RF meter, you are measuring the 4G LTE or 5G signal transmitting in the low or mid band, not a super-20 GHz mmWave 5G signal. Our RF meters cannot measure 24, 28 or 39 GHz, which are the frequencies cell carriers use in the mmWave band (with more mmWave band frequencies to be auctioned off by the FCC).

In my efforts to help my electrically sensitive clients avoid RF exposure from Fifth Generation cell technology, I am telling them that as they oppose small cell antennas in their neighborhood, if a small cell antenna does end up in front of their house in spite of their efforts to stop it, what they *don't* want, as I said above, is a 4G model. The 4G LTE signal will be always-on and constantly broadcasting in a wide path.

The super 20 GHz mmWave 5G signal, on the other hand, from that small cell antenna will be on-demand. When it does transmit, the signal will be 10 degrees wide, aimed at the house of the neighbor who has a new 5G-enabled cell phone.

I am therefore realizing that if one only has a beam-formed mmWave 5G antenna in front of their house, that could theoretically be somewhat less of a threat to an electrically sensitive person than a 4G LTE small cell transmitter for the following reason: That beam-formed 5G antenna would not be transmitting high levels of RF energy into their house on a constant basis, as would be the case with a 4G LTE or low or mid band 5G antenna. Instead, that beam would be narrow and only sent into the home of a neighbor using a 5G-enabled phone, and only when that neighbor's phone calls for a connection.

This assumes an electrically sensitive person will not purchase a cell phone capable of connecting with a 5G cell antenna transmitting in the high, mmWave band and no one else in their household does, either. Otherwise, that 5G-enabled phone *will* pull in that signal.

This also assumes the electrically sensitive person lives on a certain street in one of those urban neighborhoods near city centers that have high mmWave band 5G deployed.

5G service in the low band, on the other hand, from T-Mobile and AT&T would be different, meaning, not beam-formed, more wide and always-on.

How can you tell if a small cell antenna is a mmWave 5G antenna and not a 4G antenna? If you cannot measure a signal with your RF meter, it will be a 5G antenna transmitting in the mmWave band with no 4G or 5G signal in the low or mid band.

If, on the other hand, you do measure a strong signal on your RF meter that you determine is coming from that antenna, then it has a 4G or a low or mid band 5G transmitter in it.

You can put your RF meter in front of your chest and turn around in place in a circle. If the RF signal on your meter drops when your back is to the antenna and increases when you turn so that you are facing it, and if the strength of the RF signal level and its sound increases as you walk towards it, that is proof that that antenna is the source.

You will also have other signals mixed in from 4G cell antennas some distance away that all sound the same (a high-pitched squeal), but you can use your hands to block the signal on different sides of the RF meter and also use your body to block it. The water in our bodies and hands is an excellent shield that blocks RF signals. This helps determine the direction of RF sources.

If you have a 4G or low or mid band 5G small cell array near your house, you can shield the RF signals with Y-Shield paint (two layers) or building foil or fabric, plus window shielding. That will block both 4G LTE and 5G signals in the low to mid bands. Only paint and building foil will block super-20 GHz 5G signals. Fabric, except the Aaronia silver fabric, will not block mmWave 5G signals well. A link to the Aaronia fabric is provided on page 6.

Don't Forget the Many RF Sources Inside Your Home

It goes without saying that everyone needs to pay extra attention to eliminating *all* RF sources inside your homes, including Wi-Fi, Bluetooth, etc. from cell phones, tablets, laptops, cordless telephones, smart TVs, etc. We have hardwired alternatives for all of that on my website, such as on the Safer Use of Computers page, at https://createhealthyhomes.com/safercomputers.php.

Many of my clients worry about 5G, yet they also have wireless sources throughout their home. Clients often have me evaluate their homes because of fears of 5G. We routinely find a half-dozen wireless devices emitting very high RF signals right inside the house. Chief among them are the clients' cell phone. I have noticed that Bluetooth now constantly emits radio frequencies on most iPhones. Check that for yourself with your RF meter. Listen to the sounds that cell phones make, right in your pocket and on your bedside table.

This is all very complicated, to say the least, but I hope it has helped. I suggest that folks consider reading through this material more than once, possibly with some time between readings so the information sinks in. You will pick up and remember more of it with each re-reading.

I also suggest that you consider downloading the online course on 5G that we wrote on the Building Biology Institute website at https://buildingbiologyinstitute.org/course/electromagnetic-radiation/5g-cellular-phone-systems/.

Listen to interviews I have conducted on 5G with Patti and Doug Wood on Green Street Radio and WBAI, at https://www.greenstreetradio.com/post/emfs-5g-and-you-a-conversation-with-oram-miller-full-interview, as well as with Lloyd Burrell, at https://www.electricsense.com/emf-protection-electrically-sensitive/.