



RF Exposure in a Building Environment from an Indoor HetNet Compared to a Nearby Rooftop Site or Cell Tower

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Introduction

In the world of increasingly present wireless signals, are occupants of a high-rise building affected by Radio Frequency (RF) exposure from cellular systems that provide cell phone coverage to them? Are the people safe around these systems? What level of risk are they exposed to? Consider the options of cell service provided by a rooftop or tower cell site across the street from the building in comparison to an in-building Heterogeneous Network (HetNet), such as a Distributed Antenna System (DAS) or small cell network communications system. Which type of communications system provides the most RF exposure to the occupants? This paper addresses these issues starting with how electromagnetic radio waves affect both people and medical devices. It covers acceptable levels of RF exposure and explains how well a type of communications system fairs under these standards.

RF Exposure and Required Reference Levels

RF exposure guidelines govern:

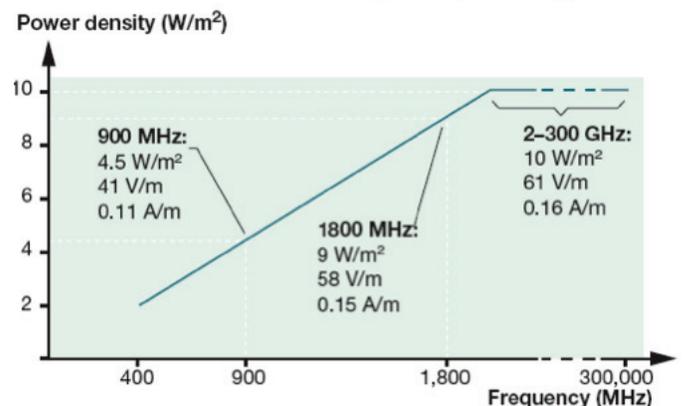
- Specific Absorption Rate (SAR) to the human body
- Electromagnetic interference to other electronic devices

Specific Absorption Rate

There are guidelines for the level of RF exposure to a human being from a transmitting device, such as a cellular

antenna. Signals transmitted by this type of device can be absorbed by the human body. There are limits on the amount of RF signal energy that a human body can absorb without any negative health effects. The rate of RF absorption by the human body is specified as the SAR. The general public SAR guidelines refer to how much RF energy exposure is safe for people who do not have controlled access to radio transmitting equipment but will be in the area exposed by an RF source. Occupational personnel SAR guidelines refer to allowable RF energy exposure for people who have access to and work with radio wave emitting equipment. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has published reference levels acceptable to the general public as shown below:

The ICNIRP reference levels for general public exposure



ICNIRP, "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)", International Commission on Non-Ionizing Radiation Protection (ICNIRP), *Health Physics*, vol. 74, pp 494-522, April 1998. www.icnirp.org

Source: *Radio Waves & Health, In-building solutions*, Ericsson

This provides guidelines for human beings in the vicinity of an RF transmitter. It is affected by transmit power, frequency and distance from the RF emitting source (e.g., antenna).

Allowable occupational personnel exposure values are five times greater than for the general public.

Electromagnetic Interference

Electromagnetic interference can operationally alter, degrade or immobilize an electronic device that is close to an RF transmitter, such as an antenna. Of particular concern are medical devices, like pacemakers and hearing aids. For example, strong electromagnetic fields have been shown to affect the operation of pacemakers. Guidelines have been developed for how close one of these devices can be to an RF transmission source and still operate safely and reliably.

Medical equipment must operate satisfactorily in an environment with the following amount of electric field strength:

- Non-life-supporting equipment: 3 V/m
- Life-supporting equipment: 10 V/m

HetNet Versus Outdoor Rooftop or Tower

How does an indoor HetNet compare to a nearby rooftop or tower in terms of RF exposure to occupants of a high-rise building? If a tower or rooftop is across the street from a high rise, is the RF exposure to the building occupants better or worse than from a HetNet operating in the building? Two RF sources must be addressed:

1. Transmission of the rooftop, tower or HetNet antenna
2. RF emission of the mobile phone

Exposure to Rooftop, Tower or HetNet Antenna

It may seem surprising that the signals from a rooftop, tower or HetNet antenna are not as significant to the human body as the mobile phone signal. Why? Because

these antennas are further away from the human body than the mobile phone. A person usually holds a mobile phone next to their head whereas other types of antennas are much further away. Distance is a big factor in how strongly a signal penetrates the human body. The body absorbs a stronger signal from a mobile phone because it is so close. So what is a safe distance from a rooftop, tower or HetNet antenna, and will building occupants likely maintain that distance?

Rooftop or Tower Antenna

Even though a rooftop or tower antenna outputs a lot of RF energy, this energy is well dissipated when located across the street from a building. A tower technician would need to take precaution when climbing near one of these antennas but occupants of a nearby building across the street do not. Again, the impact of these signals on the human body will be weaker than those from a mobile phone.

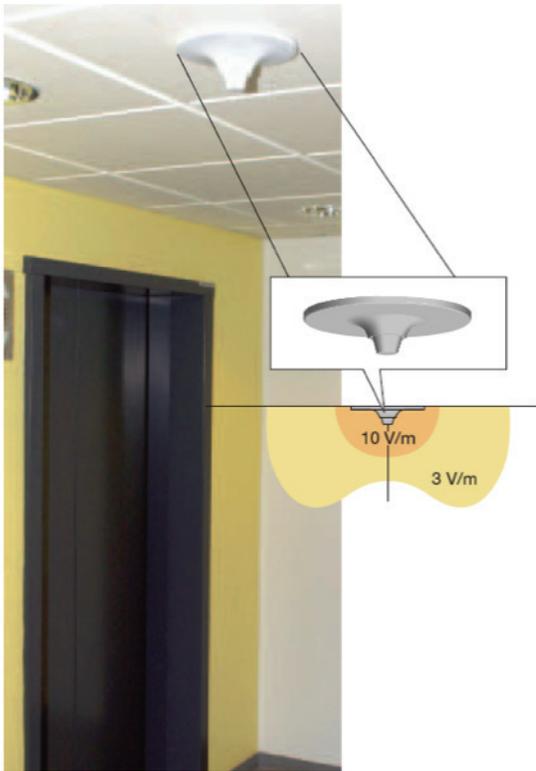
HetNet Antenna

What about an indoor HetNet antenna? It could be installed in an eight- or ten-foot ceiling, directly above a building occupant. Based on a standard HetNet power level, as defined in the referenced Ericsson paper, safe distances from the antenna are as follows:

- General SAR exposure meets the ICNIRP guidelines for basic restrictions at a distance of 10 cm from the antenna.
- Medical device electromagnetic interference meets life-supporting sustainability guidelines at a distance of 20 cm and non-life-supporting sustainability guidelines at a distance of 40 cm.

In summary, the safe distance from the main beam of an antenna is one meter, longer for other locations.





At a distance of 20 cm, the electric field strength of a typical omni-directional in-building antenna (GSM 1800 MHz, EIRP 100 mW) is 10 V/m (immunity level for life-supporting equipment). The immunity for non-life-supporting equipment, 3 V/m, is met at 40 cm.

Source: *Radio Waves & Health, In-building solutions*, Ericsson

So an indoor HetNet antenna provides no threat in terms of general SAR exposure and will not affect medical devices for the general public that maintains a distance of 40 cm or more from an antenna. Keep in mind that these are general guidelines and that specific verification of a HetNet antenna's RF exposure characteristics is recommended where there is a stated concern.

Exposure to Mobile Phone Signals and the HetNet Advantage

As stated already, the location of a mobile phone next to a person's body provides a stronger signal density that can be absorbed by the body than the signal from a rooftop, tower or HetNet antenna. HetNet offers an advantage over a neighboring rooftop or tower when trying to minimize RF exposure to the building occupants.

When a mobile phone user makes a call in a building that has an installed HetNet, the mobile phone RF transmission power is reduced significantly compared to when there is no HetNet installed. Why is this? The mobile phone is communicating with HetNet antennas that are close to the mobile user. The mobile device does not have to "power up" nearly as much to connect with a close HetNet antenna compared to when it communicates with a tower located across the street or further away. The advantages here are extended battery life of the mobile phone and lower-power radio wave emissions from the phone.

Summary

- A rooftop or tower located across the street from a building generates RF signals inside the building that fall well below the maximum allowable RF exposure for building occupants. It is significantly less than the impact of operating a mobile phone next to a person's head.
- A typical HetNet antenna satisfies RF exposure guidelines for any person separated from the antenna at a distance of 10 cm or more.
- A typical HetNet antenna will not affect life-supporting medical devices located distances greater than 20 cm from it.
- A typical HetNet antenna will not affect non-life-supporting medical devices located distances greater than 40 cm from it.
- A mobile phone will operate at lower power and have extended battery life when communicating with an in-building HetNet compared to a rooftop or tower located across the street or further away, potentially increasing the safety of using a mobile phone.

