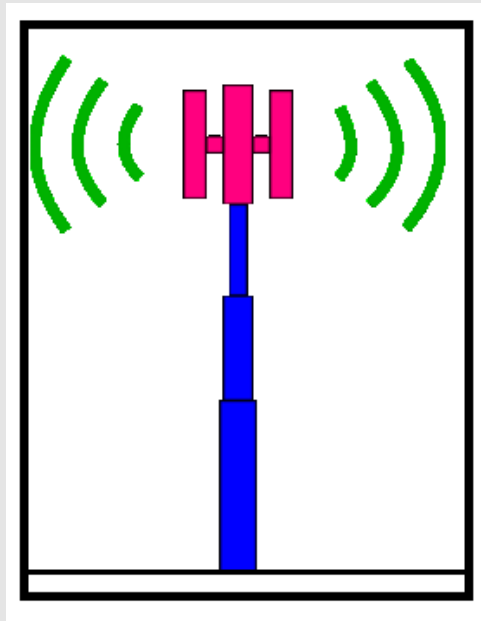


# Radiofrequency (RF) Safety Overview

## Massachusetts Environmental Health Association



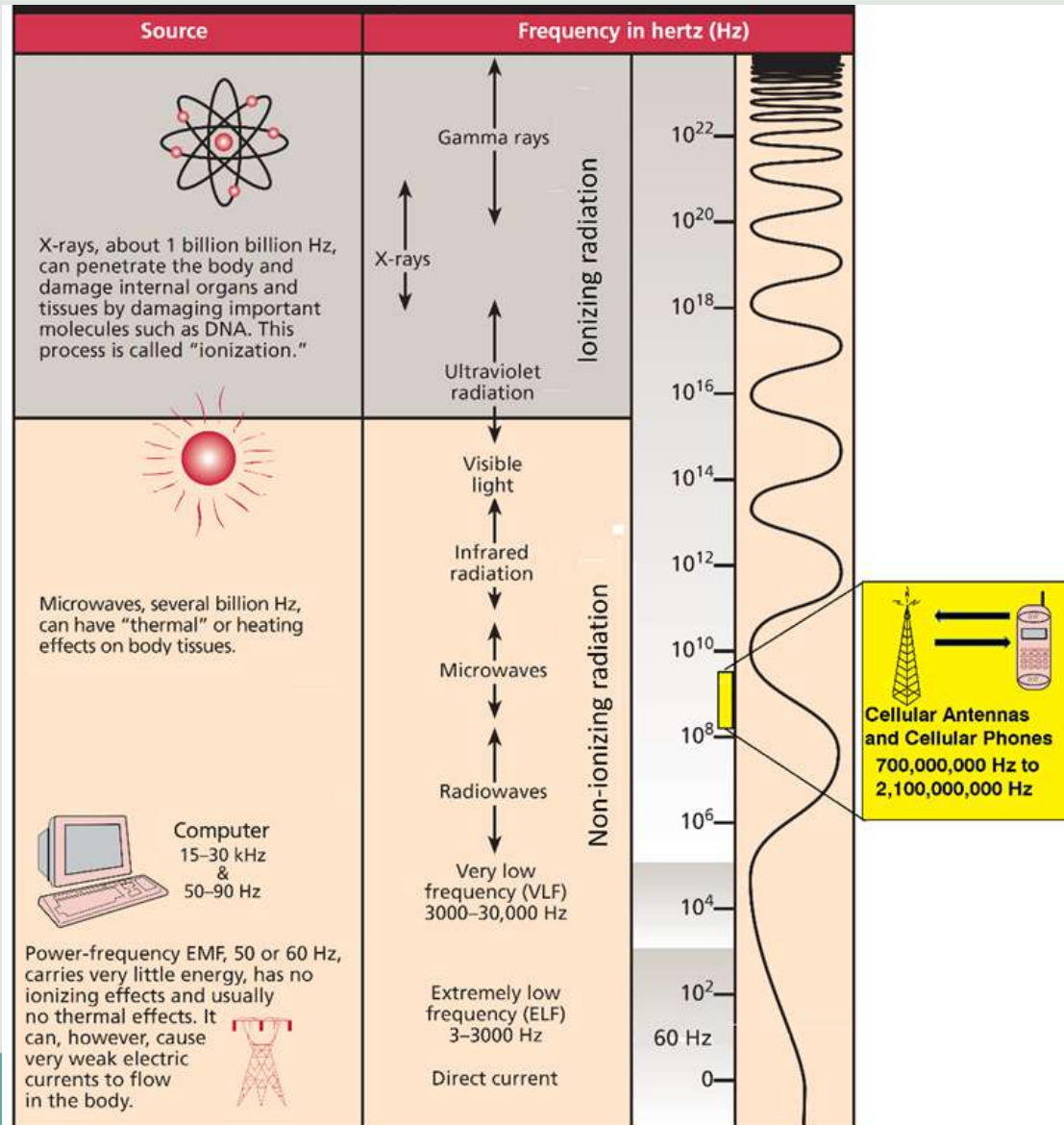
May 16, 2018

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781-254-5727 (cell)

# Agenda

- 1) **RF-EME 101**
  - a) **What is RF energy?**
  - b) **Antenna Basics**
  - c) **Documented Health Impacts**
- 2) **FCC Regulatory Limits**
- 3) **RF Health Impacts**

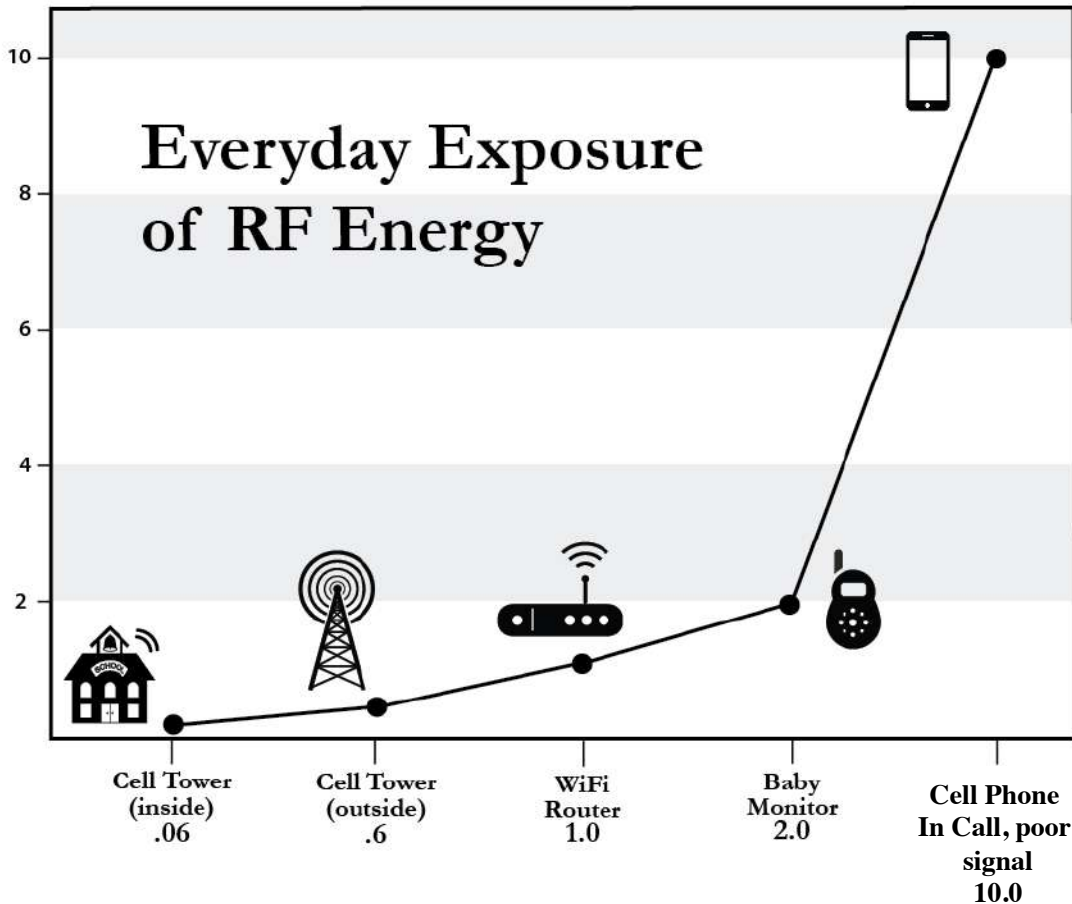
# Electromagnetic Spectrum



Microwatts per centimeter squared

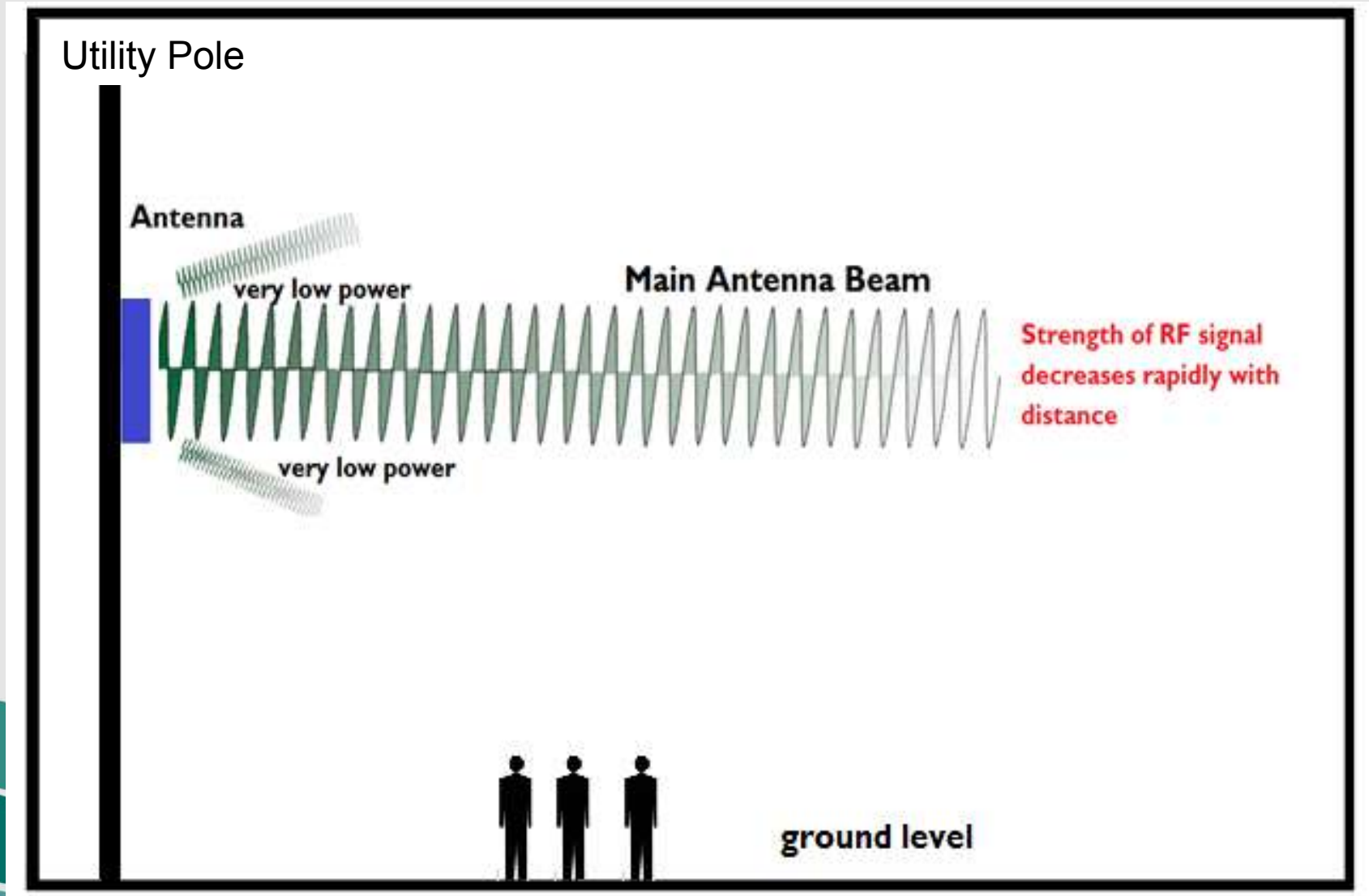
$\mu\text{W}/\text{cm}^2$

## Everyday Exposure of RF Energy

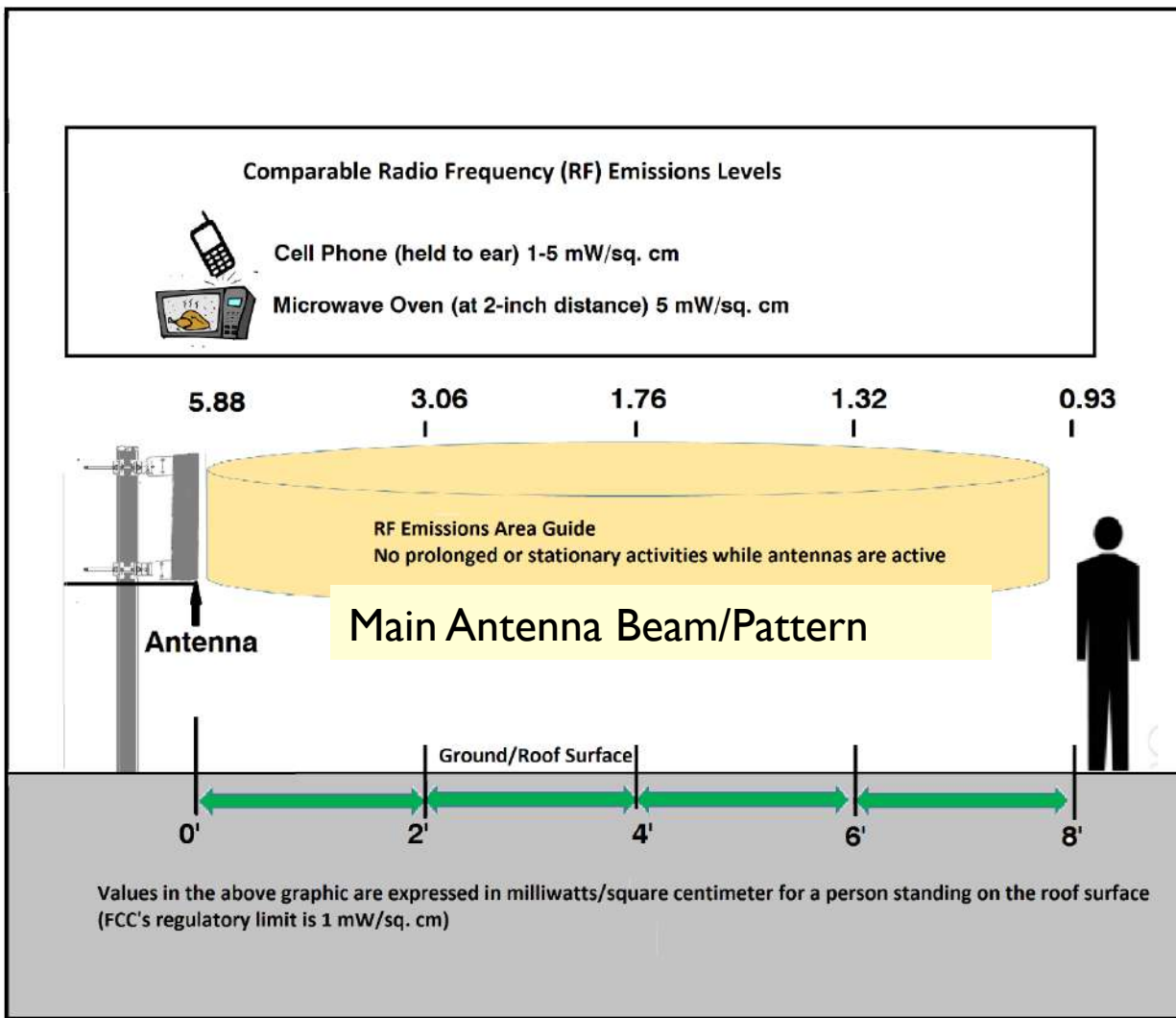


SOURCE: Sitesafe (www.sitesafe.com)

# Typical Microcell Tower Installation



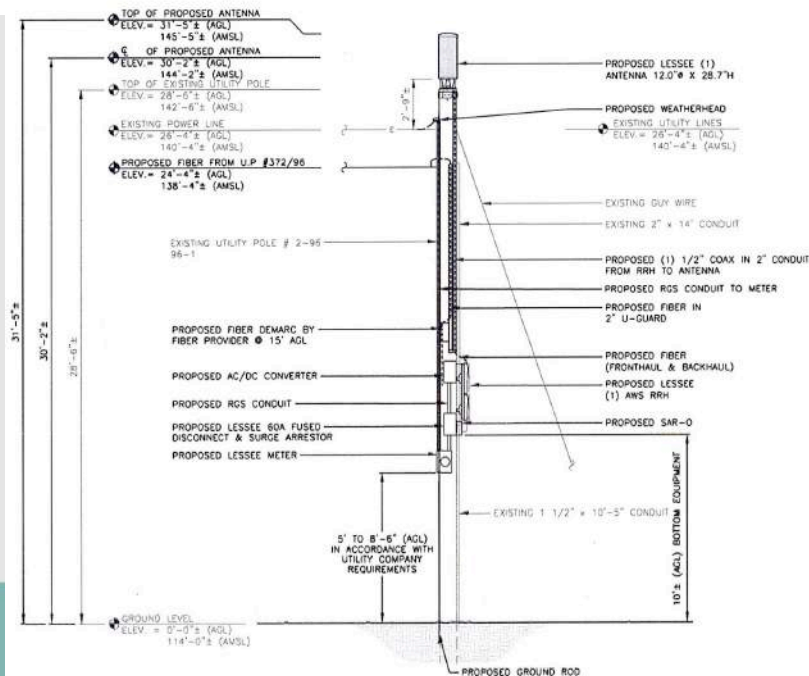
# Effect of Distance on RF Energy Levels



# Example Data from Recent MA Microcell Site Review

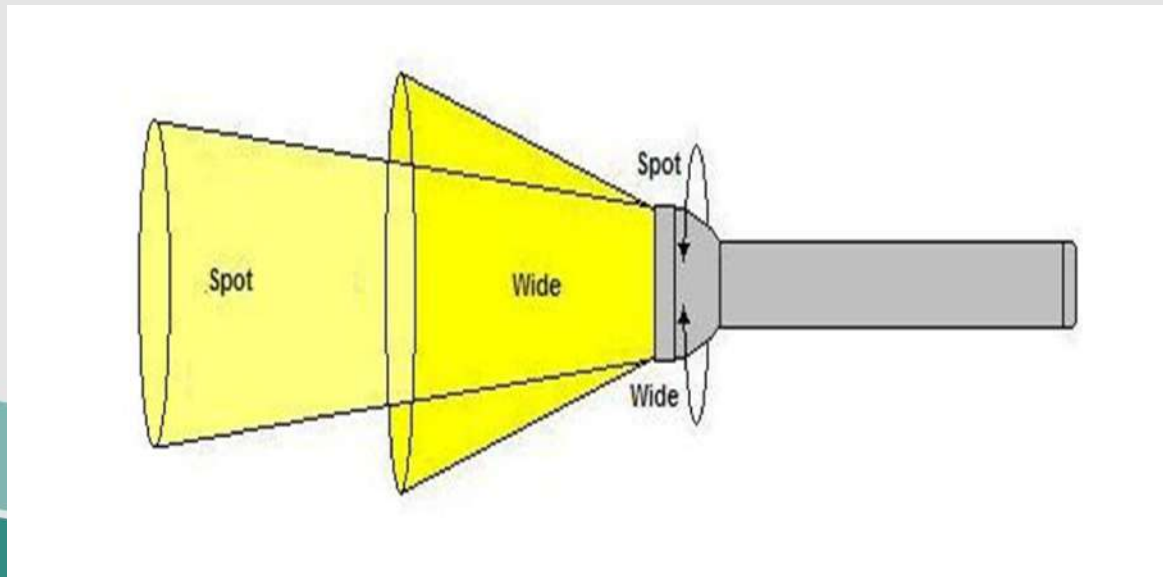
**Predicted RF Exposure Levels (as a % of the FCC's Most Stringent (General Population) Limit)**

Modeled Height	Maximum	Horizontal Distance From Antenna (feet)						
		5	10	20	40	60	80	100
Antenna Face (29' AGL)	313.00%	44.69%	11.17%	2.79%	0.70%	0.31%	0.17%	0.11%
Ground Level	3.40%	0.49%	0.12%	0.03%	0.01%	0.03%	0.02%	0.01%
Antenna Face (29' AGL)	313.00%	44.69%	11.17%	2.79%	0.70%	0.31%	0.17%	0.11%
Ground Level	3.40%	0.49%	0.12%	0.03%	0.01%	0.03%	0.02%	0.01%



# Directional (Panel) vs. Omni Antennas

- Antennas shape and project RF energy waves in a specific direction
- Panel antennas produce more focused signal (higher gain) than an omnidirectional antenna
- Analogy: A flashlight (vs. a light bulb)





## Some Facts About RF Energy To Keep In Mind

- RF energy levels decline significantly as one moves away from an RF source (in much the same way that visible light sources decrease in intensity with distance)
- Wireless antennas are designed and installed to send RF signals towards the horizon, away from the building or tower; antennas are designed to direct very little power downward (toward the ground or roof surfaces)

## Some Facts About RF Energy To Keep In Mind (cont.)

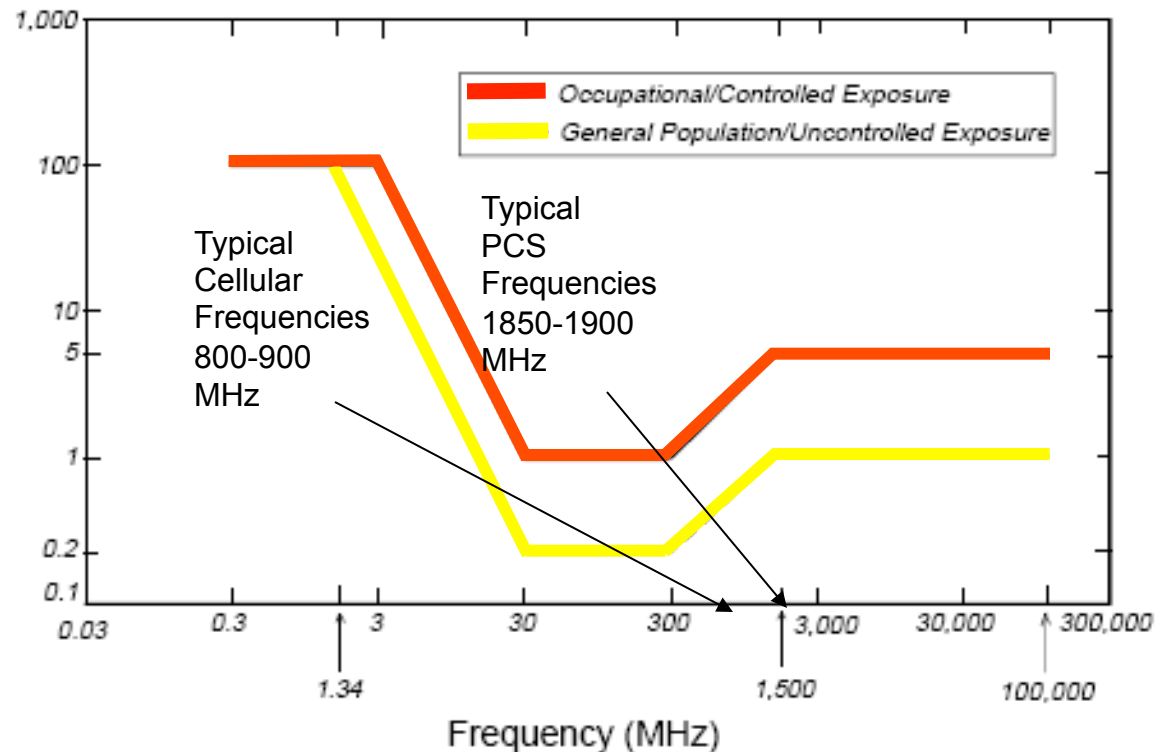
- Within buildings, the weak RF emissions at the roof surface level are further reduced by the intervening roof materials. In many cases, roof surfaces reduce RF signals by 90% or more.
- All cell carriers operating antennas are required by state and Federal regulations to meet specified emission limits and provide safety measures to prevent harmful RF exposures.

# FCC's Maximum Permissible Exposure Limits for Licensed RF Transmitters

- The occupational or controlled MPE limit applies to individuals who may come into contact with RF EME as a consequence of employment, but have been made fully aware of the potential for exposure and have the ability to exercise control over the exposure.
- The general population or uncontrolled MPE limit applies to the exposure the general public may experience, and they are generally unaware of the potential for exposure.

# Maximum Permissible Exposure Limits

*Figure 1. FCC Limits for Maximum Permissible Exposure (MPE)  
Plane-wave Equivalent Power Density*



## In the Typical Wireless Carrier Range (>1800 MHz)

*Controlled Exposure:*  
5 mW/cm<sup>2</sup> (6-minute avg)

*Uncontrolled Exposure:*  
1 mW/cm<sup>2</sup> (30-minute avg)

# Commonly-used Frequencies

- AM Radio: 520 KHz-1610 KHz (commercial)
- FM Radio: 87.5 MHz-108 MHz (commercial)
- Cellular Phones: 850 MHz-2300 MHz
- Television:
  - VHF: 51 MHz-201 MHz
  - UHF: 471 MHz-801 MHz
- Microwave Oven: 2450 MHz

Low



High

# Why Do We Care About RF-EME Hazards?

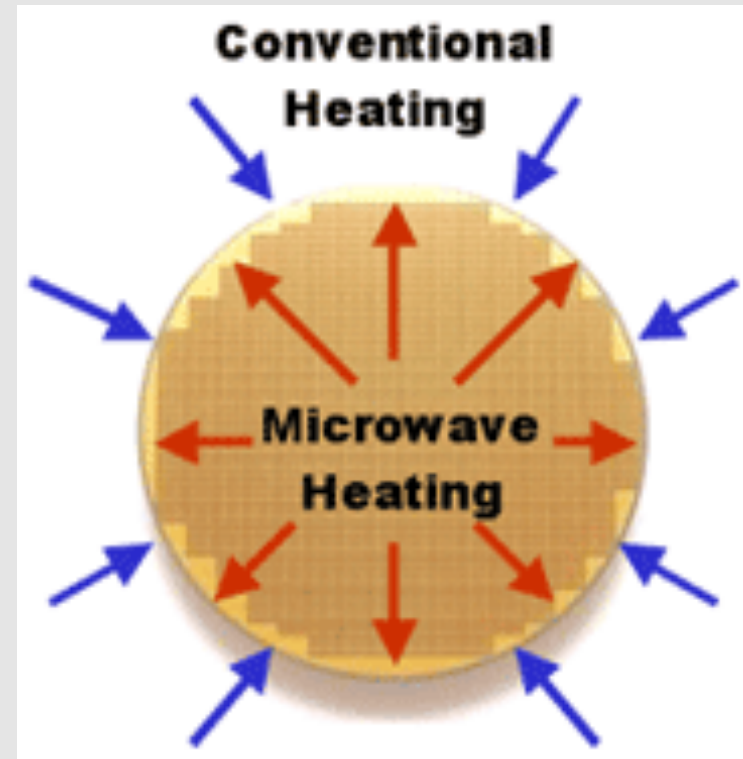
- Moving charge causes stationary charge to move
- Water molecules are polarized
- Water molecules move when an E-M wave passes
- Increased motion leads to increased body temperature (humans are made up of ~60% water)
- RF heating effects are temporary and are reduced with distance

# Injuries resulting from RF exposure incidents

- Thermal effects caused by excessive RF energy include:
  - Cataract formation
  - Keratitis (eye cornea infection/inflammation)
  - Testicular degeneration
  - Decreased sperm count
  - “Microwave Hearing”

# Health Impacts from RF & microwave fields

- ❑ RF fields at frequencies between 1 MHz and 10 GHz penetrate bodily tissue and heat it due to the absorbed energy.
- ❑ The depth of penetration decreases at higher frequencies.
- ❑ Heating occurs from the inside; it is not perceived (or it is perceived too late) because our receptors are situated near the skin surface.
- ❑ The body handles heating as a result of small amounts of RF energy through its normal thermoregulation processes.





# RF and Health Impacts

- World Health Organization: *“Studies... have not provided evidence that RF exposure from the transmitters increases the risk of cancer. Likewise, long-term animal studies have not established an increased risk of cancer from exposure to RF fields, even at levels that are much higher than produced by base stations and wireless networks.”*
- BCCDC (2016); *“Ongoing research regarding the potential health effects of RF has not demonstrated clear evidence of impacts on cancer, reproduction, and development...”*

# RF and Health Impacts

- FCC: *“Radiofrequency emissions from antennas used for cellular and PCS transmissions result in exposure levels on the ground that are typically thousands of times below safety limits. There is no reason to believe that such towers could constitute a potential health hazard to nearby residents or students.”*
- To date, no U.S. public health agencies have identified any RF health impacts beyond thermal effects (e.g. body heating)

# Some Recent Summary Documents on RF Health

NIH National Cancer Institute “Cell Phones and Cancer Risk”

<https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/cell-phones-fact-sheet>

NIH National Cancer Institute “Electromagnetic Fields and Cancer”

<https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet>

American Cancer Society “Cellular Phone Towers”

<https://www.cancer.org/cancer/cancer-causes/radiation-exposure/cellular-phone-towers.html>

British Columbia Centre for Disease Control “2016 Review: Radiofrequency and Health”

<http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/EH/RPS/BCCDC%20RF%20Health%20Report.pdf>

# Environmental Noise Sources?

- Typical Microcell Equipment list:

Table 3 – Proposed Equipment

Quantity	Description	Manufacturer	Model Number	Sound Pressure Level (dBA)	Distance (m)
2	Antenna	Amphenol	CUUX063X06F	0	n/a
2	Remote Radio Head	Ericsson	RRUS 11	0	n/a
1	Remote Optical System	Commscope	ION-M-17 HP	0	n/a
1	Remote Optical System	Commscope	ION-M7HP/85HP EU	0	n/a

- Some RRU units may be fan-cooled; need to check specification sheets

