

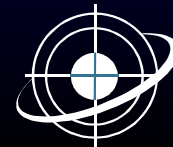
RF Radiation!

Prepared for Venable's Seminar In Telecommunications Challenges and Opportunities In Africa

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What do we need to Understand about RF Radiation?

There are three primary questions that needed to be answered:

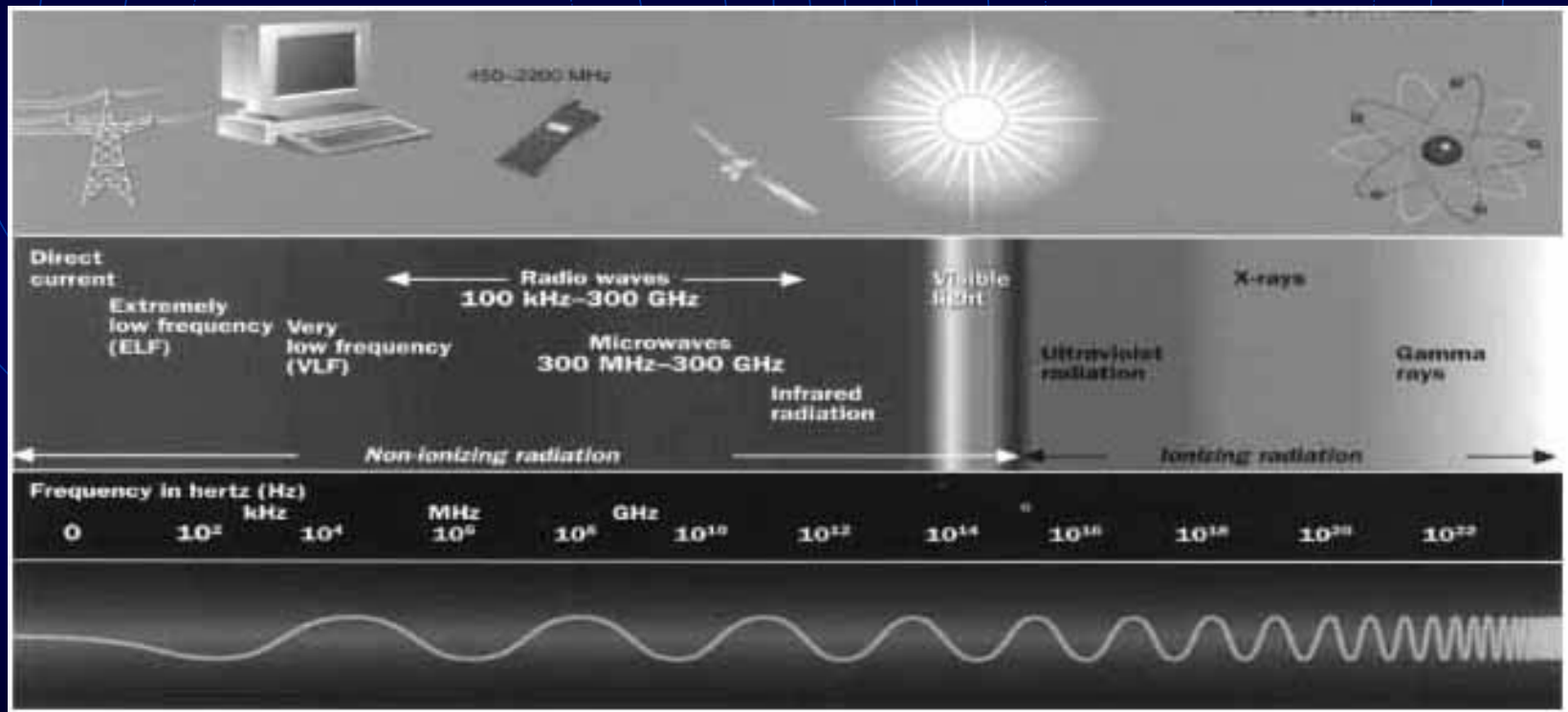
1. How do various RF fields affect the body?
2. At what levels does the body suffer adverse effects?
3. At what levels are the effects permanent?



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Electromagnetic Spectrum



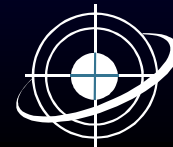
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RF Radiation History

Although there were some indications of the heating effects from the energy emitted by radio transmitters in the late 1930's, the phenomena became well known with the development of radar during the Second World War. Quite simply, people noticed that they got warm when they stood in front of radar antennas.

The first human exposure guidelines were developed by the U.S. military in the 1950's. The military funded most of the research in those days because they were the ones with most of the high power emitters. The first general RF exposure standard was issued by ANSI—the American National Standards Institute—in 1966. It suggested limiting human exposure to levels no higher than 10 mW/cm² from 10 MHz to 100 GHz. Other than the military, broadcasters were the only ones who faced concerns over RF radiation.

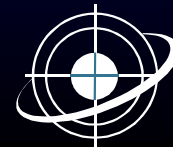


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Thermal Effect of RF Radiation

Early on we knew that the primary concern was thermal—quite simply the body heats up in the presence of significant RF energy. The first ANSI standard was a best guess and suggested limiting exposure to the same 10 mW/cm^2 field level at all frequencies. But, as research continued, it became apparent that many factors impact how much the body heats up. The concept of **Specific Absorption Rate (SAR)**, evolved. SAR defines heat absorbed into the body in units of Watts per kilogram.



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How Much Heat can the Body Tolerate?

It was determined that the most heat the human body can deal with is approximately 4 W/kg. Much of this research was based on exercise levels rather than on actual exposure experiments. And these levels are averaged over the body since our circulatory system functions much like a radiator. For this reason, an arm exposed to a strong RF field from a satellite uplink dish can tolerate about twenty times as much energy as the whole body. The eyes and a male's testes are particularly vulnerable, however, since the limited blood flow of these organs limits the benefits of the circulatory system. Time is also a factor—most standards average exposure over time, which only makes sense since we are dealing with heat. Six minutes is the averaging period for most occupational exposure limits. To put things in perspective, the normal metabolic rate when someone is sleeping is about 1.0 W/kg. It increases to about 2.4 W/kg during moderate exercise.

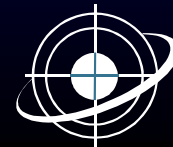


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How can RF Energy Hurt?

Moderate level exposures cause heat stress and behavioral changes. The effects are often mistaken for the flu because the symptoms are often similar. And as the level of exposure increases, the potential for harm increases. Human cells die at 107 degrees Fahrenheit. This is the reason that doctors get concerned if anyone's temperature goes above 105 degrees. The body is constantly replacing cells so the amount of damage that is done depends on how many cells are killed and what kind of cells are killed. Kill off some cells and the effects may pass in minutes or hours. Destroy a lot of liver cells for instance and you will have liver damage. If the damage is not too severe, the body will be able to repair itself. However, if the damage is extensive, the effects may be permanent!



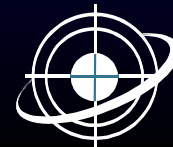
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RF Standards

Although there are dozens of standards and regulations, many refer to the limits from the major standards. If you are from North America, there are three major standards and regulations that you may be concerned with. And everyone should be aware of the ICNIRP standard because it is gaining ground as the major standard worldwide outside of North America. Therefore, the four standards covered here are:

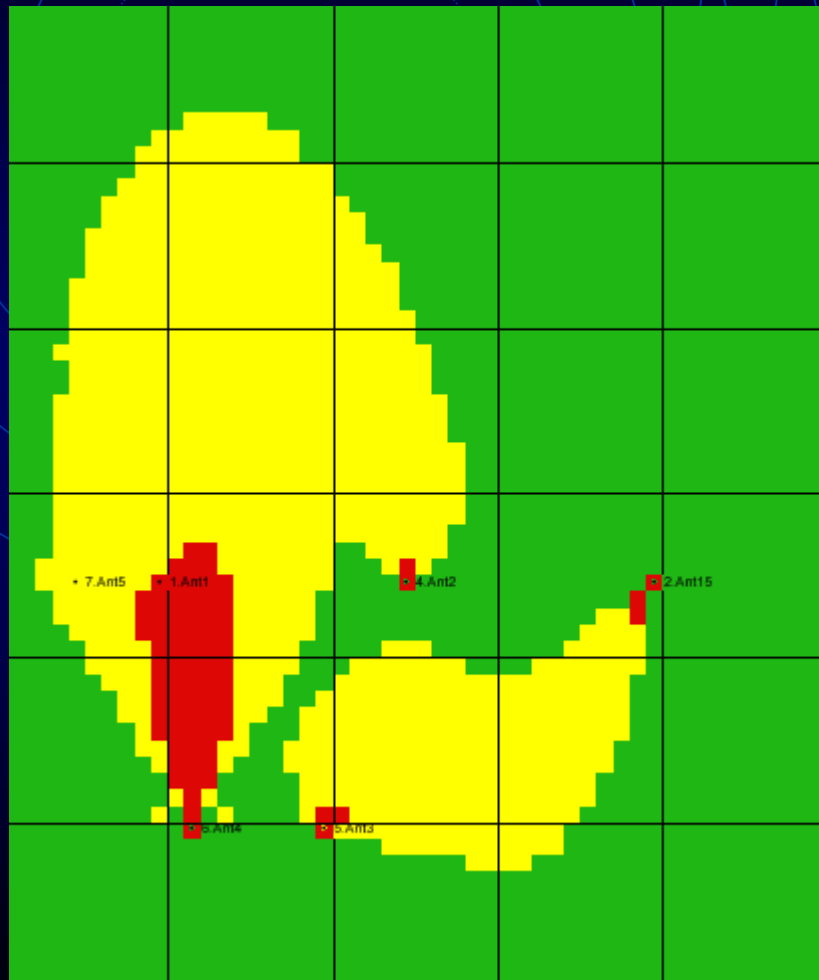
- IEEE/ANSI Standard
- FCC Regulations
- Safety Code 6 (Canada)
- ICNIRP



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RF Radiation Levels Based on FCC Standards



Statistical Summary		
% MPE	SQ. FT	%SQ. FT.
	4050	21.01 % of total ROOF Area
0 -20	3116	76.94 % of Selected Area
21 - 50	707	17.46 % of Selected Area
51 - 100	149	3.68 % of Selected Area
> 100	78	1.93 % of Selected Area

Roof Area 19280 sq. ft.
 Max %MPE 1621.6 %
 Min %MPE 1.4 %

Using Near/Far Spatial Avg Model
 With FCC 1997 Occupational Standard

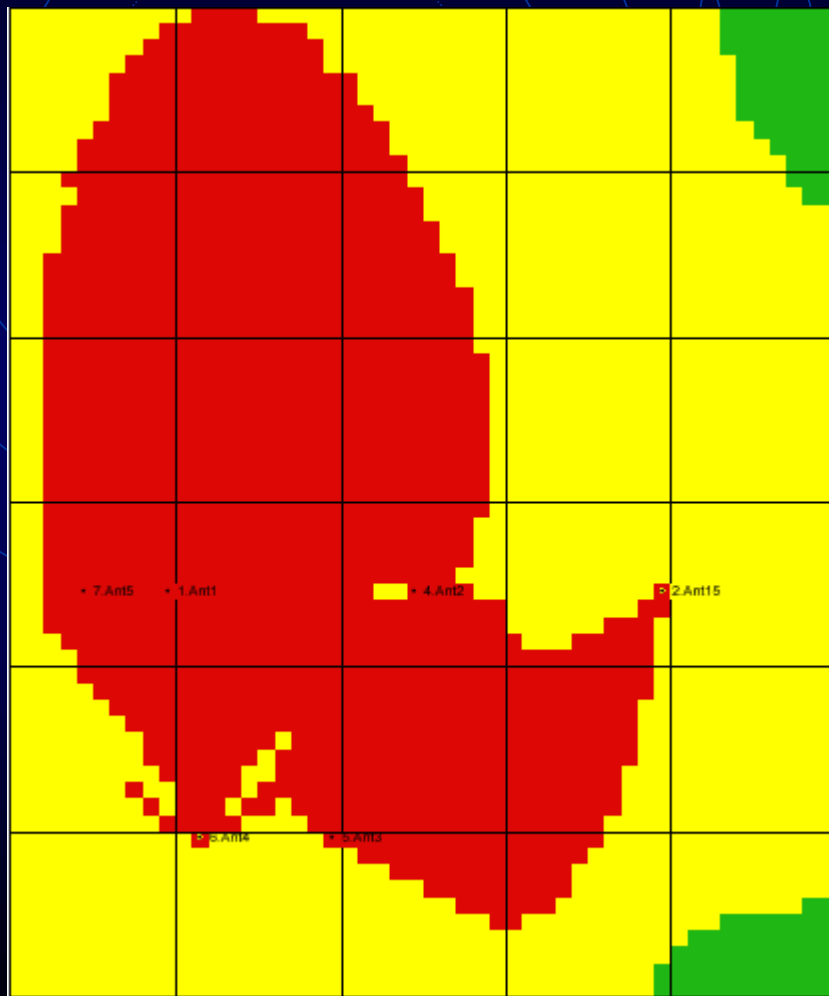
Green ≤20%
 Yellow ≤100%
 Red over 100%



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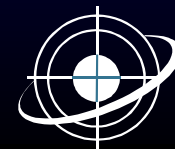
RF Radiation Levels Based on INCIRP Standards



Statistical Summary		
% MPE	SQ. FT.	%SQ. FT.
	3000	15.56 % of total ROOF Area
0 -20	112	3.73 % of Selected Area
21 - 50	904	30.13 % of Selected Area
51 - 100	702	23.40 % of Selected Area
> 100	1282	42.73 % of Selected Area

Roof Area 19280 sq. ft.
 Max %MPE 0810.5 %
 Min %MPE 14.4 %
 Using Near/Far Spatial Avg Model
 With ICNIRP 1998 General public Standard

Green $\leq 20\%$
 Yellow $\leq 100\%$
 Red over 100%



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