RF Heating in the Ham Bands

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An amateur license is a license to transmit rf energy. When you key your transmitter you generate electromagnetic and electrostatic fields around your antenna; when you receive you are tapping the far weaker fields that started at the output of someone else's transmitter. We are immersed all the time in the very weak fields of all the transmitters in operation anywhere in the community: those of other hams, commercial stations, CBers, airport control towers, paging systems, microwave ovens and even 60-Hz power transmission lines.

Rf radiation is often referred to as nonionizing radiation in order to distinguish it from the ionizing radiation that is associated with X-ray equipment and nuclear power plants. There are important differences: Ionizing radiation, for example, can have a cumulative effect. (This is why atomic plant employees and uranium miners have a lifetime total safe dose to worry about.)

Nonionizing radiation can hurt people when it causes a buildup of heat by agitating the molecules in some part of the body. An increase of 2 degrees C in the temperature of the testicles can cause temporary sterility. An increase of 10 degrees C in the temperature of the eye can cause cataracts to form. This damage is permanent. Greater increases in temperature can be fatal by literally cooking your insides.

Normally, the effect of rf exposure is not cumulative unless tissue damage occurs, since whatever heats up can cool down. The damage caused by rf radiation depends on the amount of power, distance of the individual from the power source, amount of shielding and above all the frequency. The frequency determines how much heat will be generated in the body from a given amount of rf power. It takes only some simple commonsense precautions to protect hams from rf damage in most cases.

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A Look at the Ham Bands

From 1.8-30 MHz most of the radiation passes right through you without any aftereffects. Only a small amount is converted to heat. If you consider that a 1 degree C rise in temperature is tolerable (i.e., like the low fever of a mild cold), you might have to spend an hour or more just three feet away from the feed point of an antenna radiating 500 watts of power at 8 MHz to achieve this effect.

At 144 MHz enough energy is absorbed to cause more rapid heating, and a body close to the energy source at moderate power over a prolonged period can suffer harm.

At 420 MHz about half of the rf energy is converted to heat in the body. This is probably a real danger point.

From 1000-3000 MHz the rf energy is almost completely absorbed in the body. Microwave ovens fall in this range.

At 10,000 MHz we are back to half the energy being absorbed. Still higher frequencies tend to be reflected instead of passing through, as at communication frequencies. The wavelength is such that the energy can just hit the nerve endings in the skin and provide nature's warning signal of feeling the heat.

Safety Standards

If you are operating in the 10-meter band with 1 kW of radiated power, and the operating position is 10 meters from the antenna, the power density on the operator would be about 0.8 mW/cm^2. This looks safe enough, and in fact the radiation pattern from the vertical, dipole or beam, would be such that a ham 10 meters below the feed point would be receiving less than the theoretical radiation.

Unless there were serious leaks, poor shielding, lots of rf in the shack from radiating feed lines, unbypassed leads, etc., there does not seem to be much of a problem.

2 Meters and Up

At 144 MHz and higher, the picture is quite different. First of all, more of the rf energy is converted to heat in the body. Second, although power is generally lower, a mobile antenna on the car roof is very close to the operator. And a handie-talkie wih a built-in microphone brings the operator within a couple of inches of the antenna.

If a mobile operator were transmitting with 10 watts of radiated power, and the antenna was on the left front fender, less than one meter from the driver's seat, you could easily get a power density of 10 mW/cm^2, which might be hazardous in the case of long uninterrupted transmissions. With a handie-talkie, a built-in microphone, and only one watt of radiated power, the density would be three or four times as great.

The safety precautions should be obvious. Avoid rf in the shack by using shielded or field-canceling feed lines. Use a roof-mounted antenna for mobile work in the vhf range, if possible. Avoid prolonged use of handie-talkies and use power in the milliwatt range whenever possible.

If you are sensible, and understand the frequency related nature of rf fields, you will not be at risk. I operate happily from 1.8-148 MHz myself.