Is 2 Meters Hazardous to Your Health?

How to calculate safety.

by Paul Danzer N1II

One day this could be the label on your new handie-talkie. Far-fetched idea? Well, maybe not. According to the latest radiation safety standard expected to be issued by the American National Standards Institute, we could have a problem.

A Few Definitions

The American National Standards Institute (ANSI) is a group devoted to establishing standards for both industry and government. It uses working groups of engineers, technicians, and university professors to determine what should and should not be included in these standards.

Let's begin with the conclusion. According to the ANSI specifications, we are OK. It says that unless the antenna is placed and kept next to your skin, transmitters of 7 watts or less (at 146 MHz—2 meters) are exempt. So technically our handie-talkies and little rubber duckies don't pose any problem.

But just in case—since 7 watts is not inscribed in stone as the eleventh commandment—suppose that one provision did not exist. If we calculate the field strength to which we are exposed, just how bad is it?

The power radiated from a test case of a handie with a rubber duckie depends on a host of not very well controlled things: the efficiency of the rubber duck, the effective ground plane of the body of the handie and the conductivity of our arms, among other factors.

What Do the Specifications Say?

Before starting, we have to look at the specifications and see what they say. When do we know we have a problem? For 2 meters, the 144-148 MHz band, the warning bell rings at an average power density of 1 milliwatt (mW) per square centimeter. This is the same as about 6.5 mW per square inch.

This number is calculated by taking the power out of an antenna and dividing it by the area irradiated by the antenna. If you have 10 watts coming out of an antenna, and somehow all of the power hit an area of one square inch, the average power density would be:

$$\frac{10 \text{ watts}}{1 \text{ square inch}} = 10 \text{ watts per square inch}$$

How Strong is the Field of a Rubber Duckie?

Let's take a six-inch-long rubber duckie as our antenna. We know that we are interested in distances close to the antenna—in the "near field"—and we also know the duckie will radiate in all directions pretty equally. No power comes off the ends of the antenna; instead, the power coming out looks like a cylinder, six inches high, centered on the rubber duck. (See Figure 1.)

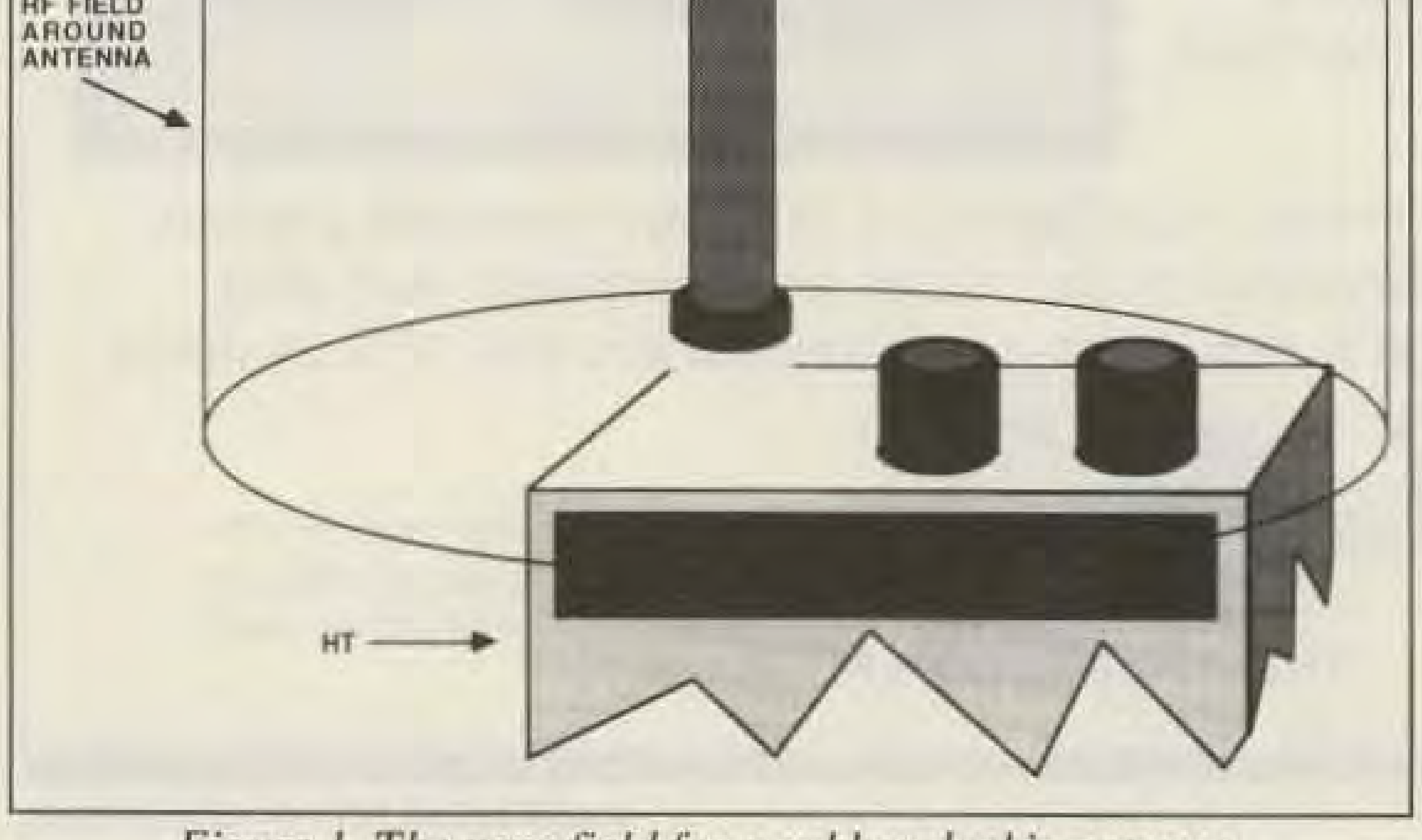

Figure 1. The near field for a rubber duckie antenna.

Armed with the formula for the area of a cylinder—Area = 2 x pi x radius x height (six inches)—we can take the total power of 1 watt and divide it by this area to get the power density at various distances from the duckie.

The curve in Figure 2 does this for us. At three inches we are up at 9 mW per square inch, and we don't get below the 6.5 mW per square inch level until four or five inches away from the duckie.

Are We OK?

I don't know about you but my rubber duckie is a lot closer than four or five inches from my head, so we had better take a little closer look.

The value calculated for three inches and the perfect rubber duckie is 8.84 mW per square inch. A real rubber duckie is not perfect, and we all know that some of them are closer to a dummy load than an antenna. But some are not bad, and a good guess is that instead of being perfect we can claim that the duckie will produce a field strength that is about 2 dB lower than perfect.

A value of 2 dB reduces the field strength by a factor of 1.6, so at three inches we can consider the power density to be reduced to about 5.5 mW/square inch. Since this is lower than the ANSI specification value of 6.5 mW per square inch, we are probably OK.

Three inches is a good guess. Looking at a

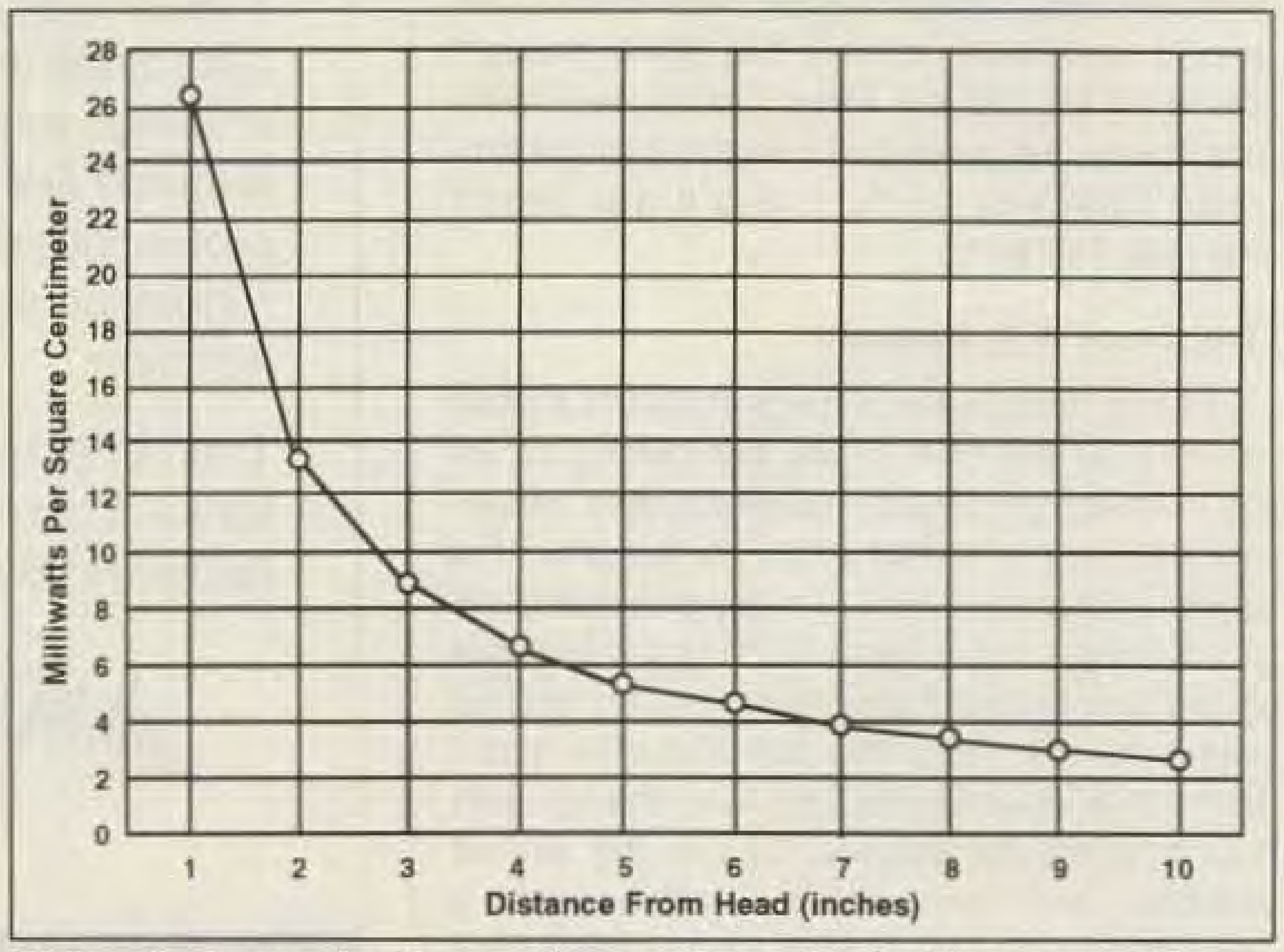

Figure 2. Power density vs. distance from the duckie antenna (1-watt transmitter).

real case (as shown in Figure 3), the handie is usually at an angle and seems to vary from perhaps two inches from the users head at the bottom to five inches away at the top. You can take your own guess and change the numbers accordingly.

Long-Winded Operators

The ANSI specifications have another provision which we should consider. It says that the power is averaged for each six-minute period. In our real case you can take the time that the transmitter is on, divide it by the time it is off (with six minutes maximum for the total on/off period), and use this factor to reduce the average of the field strength. Why a six-minute period? It is probably related to heating effects in meat (your head and my head), but in any case we have a practical solution.

Suppose three of us are on the repeater, with a long time-out setting. If each of us talk for two minutes, the on time is then two minutes out of six, or 33%. Therefore, we can take the 5.5 mW per square inch calculated before, take 33% of it, and come out with a nice safe 1.8 mW per square inch.

Higher Power Handie-Talkies

Up until now we were basing our numbers on a 1-watt handie-talkie. Suppose you are using a 5-watt unit. This would produce 5 x 1.8, or 9.2 mW per square inch—over the limit!

Or suppose we are using one of those new battery packs that provide 12 volts and maximum power—8 watts or more. Now we do have a real problem.

All of this was based on general calculations. Unfortunately, our use of handie-talkies is such that we seem to keep them close to a very vulnerable organ—our eyes—and this is probably one of the worst positions in which to put a radiating source.

Conclusion

After all of this, what can we say? Sorry, but in this increasingly complex world there is no single, simple answer. As you have seen, making a few approximations by using arithmetic comes out with some numbers which strongly suggest that a few precautions are in order:

- Keep the antenna away from you.
- Use the lowest power possible.
- Keep the duty cycle low—talk little, listen a lot, or at least don't be long-winded.

Is the handie safe? So far as we can tell, it can be used within the ANSI limits. As with almost anything in this world that you enjoy, you can take it too far, abuse it, and get into problems. But for now I am going to keep using my rubber duckie on my daily dog walks—and cutting it back to the low power position whenever possible.

Credits and Apologies

The people who put together the ANSI specifications had a very difficult task, and we can only be grateful for their efforts. To get a copy of the specifications ("American National Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI C95.1-1990), contact: The Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York NY 10017. Ask for the latest revision available.

Footnote for other VHF/UHF/microwave bands: The specifications provide a limit of 1 milliwatt per square cm for the frequency range of 100 to 300 MHz. For 3000 MHz on up the limit is 10 mW per square cm. In between, from 300 MHz to 3000 MHz, the limit is given by the formula f/300 where f is in MHz. Therefore, for operation on 450 MHz the allowable limit would be 450/300 or 1.5 mW per square cm. At 900 MHz, the result is 900/300 = 3 mW per square cm.

The low power or 7-watt exclusion applies to all transmitters operating between 100 kHz and 1.5 GHz. Additionally, there is some loosening of the requirements for partial body exposure. However, these "easier" numbers are not applicable when the part of the body includes the eyes or testes.

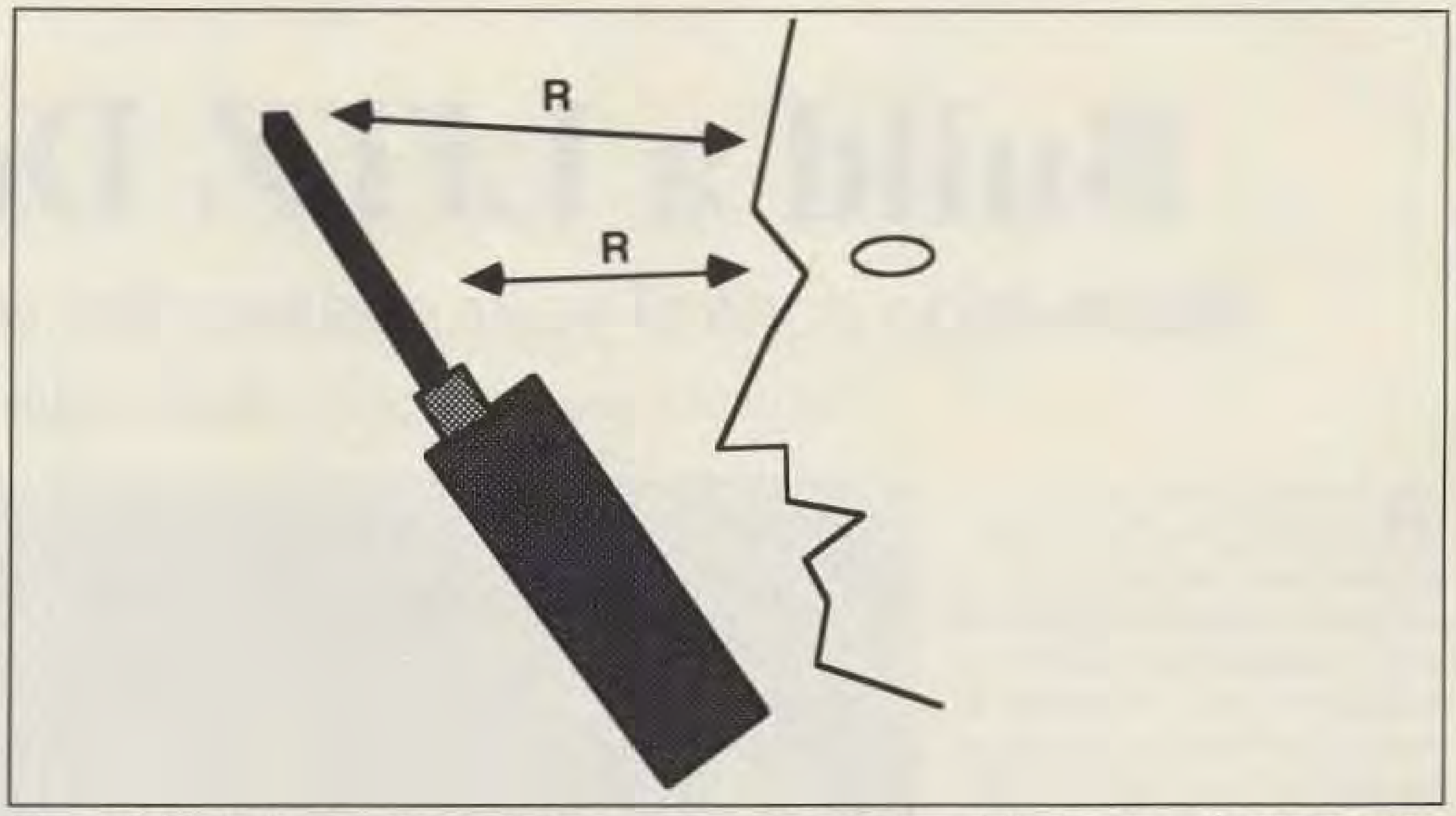

Figure 3. Typical operating positions put the antenna about 2 inches from the head at the base and about 5 inches away at the end.

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